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VOL. XXXV

A quarterly paper devoted to the sugar interests of Hawaii, and issued by the Experiment Station for circulation among the plantations of the Hawaiian Sugar Planters' Association.

JANUARY TO DECEMBER

THE HAWAIIAN PLANTERS' RECORD

VOL. XXXV

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THE HAWAIIAN PLANTERS' RECORD

Volume XXXV JANUARY, 1931 Number 1

A quarterly paper devoted to the sugar interests of Hawaii and issued by the Experiment Station for circulation among the Plantations of the Hawaiian Sugar Planters' Association.

In This Issue:

Molokai Cane Importation Project:

Methods for handling imported cane material either as cane cuttings or true cane seeds are described. Photographs accompanying the article illustrate the equipment and facilities on the island of Molokai now employed in carrying out the quarantine against foreign insects and diseases.

Factory Inspection Observations:

A short survey of recent progress in our manufacturing methods and equipment is presented.

Use of Phosphoric Acid in Improving the Quality of Commercial Sugar:

A. Fries, chemist of Honokaa Sugar Company, contributes a very timely article, which illustrates how certain sugars of poor filtering quality can be greatly improved by the use of phosphoric acid in the mixed juice prior to clarification.

We would appreciate receiving similar articles from our factory men, explaining how they have improved some step in their milling or boiling house practice. Such dissemination of knowledge will greatly aid in furthering the progress of our manufacturing technique.

The Variety Problem in Australia:

The variety problem in Australia was largely a matter of importing established varieties from different parts of the world for trial. At present, importation is only done under quarantine restrictions and seedling propagation and testing are consuming considerable interest. The testing of seedlings for disease resistance is as important as the testing for agricultural value.

The planting of varieties is controlled by a Central Board Committee, and only high sucrose and disease resistant or tolerant varieties are approved for planting. This is reflected in the continued advance in juice quality from year to year. A number of varieties are grown which average higher in juice quality than Badila.

The Forests of Siam:

An article pertaining to the forests of Siam is presented, describing certain species of trees that occur in these forests, methods of cutting and marketing the lumber, etc.

Diseases of the Avocado:

An introductory paper on this subject was presented at the Third Annual Meeting of the Avocado Association of Hawaii, November 25, 1930. Critical studies of avocado diseases in Hawaii, which should serve as a foundation for an authoritative discussion, have not been made. The material is largely an interpretation of the literature as it seems to apply to our local industry.

Java's Sugar Industry:

An article on the sugar industry of Java contains a condensed review of the development of Java as a colony of The Netherlands, the basic reasons for the satisfactory labor supply, the success of the sugar industry and its present-day organization.

Clarification and Its Influences on the Refining Qualities of Sugar:

A brief description of the Dorr clarifier and the Petree process is presented. Clarification experiments, which revealed the causes of the poor clarification at Hamakua Mill Company, are described in detail. Further experiments showing the improvement in clarification that could be secured through the addition of small quantities of superphosphate to the raw primary juice are also presented. The effect on the refining quality of the commercial sugar is discussed when the results of the laboratory experiments were applied to the factory procedure.

Annual Synopsis of Mill Data:

The Annual Synopsis for 1930 is presented. Statistical data and the discussion of technical results are in much the same form as in recent years.

Molokai Cane Importation Project

By J. P. Martin

To carry on a systematic breeding program it is necessary for the geneticists to have at their command a large collection of superior canes as soon as possible. Such a collection may be built up by importing cuttings of desirable varieties or by importing true cane seeds which are collected from tassels of desired crosses made abroad.

A collection of outstanding foreign canes containing both commercial and wild types is being acquired in Hawaii under special rules and regulations as stipulated by the quarantine committee of the Experiment Station in addition to the Federal and Territorial laws and rules governing the importation of living sugar cane material into the Territory of Hawaii. All questions dealing with the importation of cane material are passed on by a quarantine committee composed of the following members: H. P. Agee, chairman; O. H. Swezey, F. X. Williams, C. E. Pemberton, H. L. Lyon, J. P. Martin, C. W. Carpenter, J. A. Verret, A. J. Mangelsdorf and Y. Kutsunai. Within the last year rapid progress has been made on this very important phase of sugar cane culture.

There are serious problems associated with the building up of such a collection of foreign varieties that must receive careful consideration. For instance, methods for handling imported cane material must have been perfected in order to reduce to a minimum the possibility of introducing a foreign insect or disease.

The object of this article is to present the methods exercised in dealing with imported cane material and to show in the accompanying illustrations the equipment and facilities now employed in carrying out the quarantine against foreign insects and diseases. The photographs of these illustrations were taken by various members of the quarantine committee.

As mentioned above, sugar cane material may be imported into the Territory as cane cuttings or as true cane seeds. The following is an outline showing the various measures to which the introduced cane material is subjected before being released to plantations or used for breeding superior canes for Hawaiian conditions:

Imported as Cane Cuttings

1. *Received in Honolulu,* packed in moist charcoal, in sealed metal containers, taken to Molokai and opened in Quarantine House No. 1 for inspection.

Imported As Cane Seed

1. *Received in Honolulu,* in sealed containers either as threshed seed or as fuzz. The threshed seed is planted directly in the germinating house after receiving surface sterilization. The fuzz in its container is opened within a threshing chamber, where the seeds are separated from the fuzz. The seeds while still in the chamber are given surface sterilization, packed in sealed containers, and transferred to the germinating house for planting.

2. *Quarantine House No. 1, Kanoa.* Cuttings are inspected for insects and diseases, thoroughly disinfected externally and are planted in large concrete pots. The varieties are grown for a period of four months, or until the entomologists can certify that no foreign insects are present. Frequent inspections are made by entomologists and pathologists. Selected cuttings are transferred to Quarantine House No. 2 in sealed containers.

3. *Quarantine House No. 2, Kanoa.* The selected cuttings are immersed in water at 52° C. for 15 minutes, which eliminates many organisms if present. Contact plantings are then made with standard varieties in a large soil pit. During the minimum 9 months growth period frequent inspections are made. In the absence of foreign diseases and insects cuttings are taken to Kawela Quarantine Field.

4. *Quarantine Field, Kawela.* During the field quarantine of 12 months the varieties are rapidly propagated in contact with the standard commercial varieties. Repeated inspections of the canes are made.

5. *Release to Plantations.* A critical inspection of the canes is finally made and if they are found to be free from foreign diseases and insects they are cut, boxed and shipped to plantations.

2. *Germinating House, Mapulehu Range.* The seeds are planted in flats of sterilized soil and are handled by the ordinary methods. When growth warrants, the flats are removed to the seedling house for transplanting.

3. *Seedling House, Mapulehu Range.* Individual seedlings are transplanted to sterilized soil in one gallon tins. The seedlings are grown for a minimum period of 6 months with frequent inspections. A rigid examination is made of all plants before cuttings are taken to the planting field.

4. *Quarantine Field, Mapulehu.* Here the seedlings are grown in contact with standard varieties for a definite period. During this time the seedlings are inspected by the entomologists and pathologists.

5. *Release to Plantations.* Since the majority of these seedlings are to be used for breeding purposes, only a few of the superior ones are released to the plantations.

Fig. 1. Site selected for the quarantine houses shown in Fig. 2 at Kanoa. Houses are surrounded by kiawe forests, which make for good isolation. This location is five miles east of the town of Kaunakakai.

Fig. 2. Quarantine units at Kanoa. Caretaker's house at extreme left; shed which houses a steam sterilizer; Quarantine House No. 1 and Quarantine House No. 2. Imported cuttings are first inspected and planted in large concrete pots in House No. 1, and are grown for a period of three to four months. If at the end of this period no foreign insects or diseases are present, cuttings are selected from each variety and removed to Quarantine House No. 2, where they are planted in a large soil pit with standard varieties. The contact planting with the standard varieties makes it possible to determine if normal growth is being secured within the house and also aids in studying abnormalities on the imported varieties should they occur. The canes are retained in Quarantine House No. 2 for a minimum period of nine months, and if they remain free from foreign diseases and insects, cuttings are again selected and planted under field quarantine at Kawela.

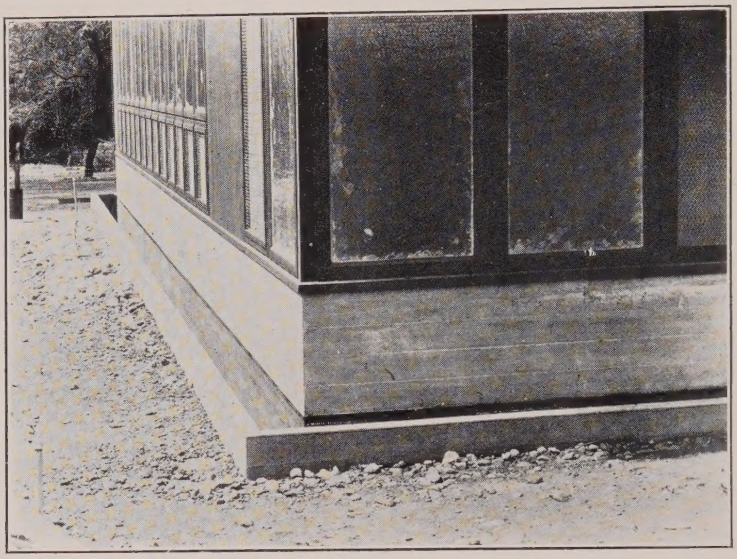


Fig. 3. A moat filled with water surrounds Quarantine House No. 2, which prevents wingless insects getting onto, and possibly into, the house.

Fig. 4. P. O. J. 2878 growing in Kawela Quarantine Field, which is located one mile east of Kanoa. During the field quarantine, which extends over a period of twelve months, the varieties are rapidly propagated in order to have the maximum number of cuttings to forward to the plantations when the varieties are released. Frequent observations are made of the canes while under field quarantine.

Fig. 5. Cutting, inspecting and boxing cane cuttings of P. O. J. 2878 at Kawela Field prior to the release of this variety to plantations.

Fig. 6. A stool of P. O. J. 2878 growing in Kawela Field. This stool exhibits a large number of well-developed stalks. The plantings of this variety were supplied with an abundance of nitrogen in order to promote good growth and rapid multiplication. As a result of this treatment, P. O. J. 2878 produced no tassels in 1929, even though the cane was about one year old.

Fig. 7. The Mapulehu Range under construction at Mapulehu, which is situated seventeen miles east of Kaunakakai. This location is well isolated from the Kanoa and Kawela units.

Fig. 8. Mapulehu Range consists of a germinating house connected by a vestibule to a large seedling house. Cane material imported as true seeds is handled at Mapulehu Range, being germinated in the germinating house and later transferred to the large seedling house. Here the seedlings are grown for the remainder of their quarantine, or a minimum period of six months. Frequent inspections are made of the seedlings before they are released. Only cuttings of the seedlings are removed from the house and are planted in a quarantine field at Mapulehu. All cane trash, roots and soil in the pots used for culturing the seedlings are sterilized in a large steam sterilizer and the house is thoroughly cleaned before another lot of seedlings is handled.

Fig. 9. Interior view of the large seedling house of the Mapulehu Range, showing a portion of the Australian seedlings growing in small paper pots. The seedlings are later transferred to one-gallon pineapple tins. The house will accommodate 5,000 seedlings in this manner.

Fig. 10. The Australian seedlings growing in the seedling house at Mapulehu Range. These seedlings were grown from cane seeds which were collected from crosses made by C. G. Lennox in Australia, 1930.

Fig. 11. The threshing chamber where tins containing the imported fuzz are opened and the seeds are separated from the fuzz by methods which prevent the escape of fungus spores. The cane seeds are given surface sterilization while still within the chamber and are packed in small sealed glass vials. The seeds are then planted in the germinating house of Mapulehu Range.

Fig. 12. Planting cuttings of the Indian seedlings at Mapulehu quarantine field after being released from the seedling house. The Indian seedlings were grown from true cane seeds which were collected from crosses made by U. K. Das in India, 1929.

Factory Inspection Observations—1930

By W. L. McCleery

Boiler Feed Water

Condensed vapor from the evaporators has been substituted for raw make-up water at several factories. We consider this desirable because the introduction of scale-forming solids is avoided and heat economy is improved. Using condensed vapor, however, increases the importance of controlling the reaction of the water in the boilers, for without such control the pH will drop to very low points and in the absence of a protective coating of scale, corrosion can be anticipated. The reaction of the water can be corrected without difficulty by adding controlled amounts of alkali in the feed water. Tentatively we have been recommending a pH of 8.3 or moderately higher in the water in the boilers. This point is easy to check as it is the lowest pH at which phenolphthalein indicator will show a red or pink color.

There are now 23 factories making pH determinations on boiler water as a part of the regular laboratory routine. During factory inspections this year the pH was above 8.3 at 21 factories and below at 16 factories. The Boiler Inspection Bureau informs us that corrosion is now much less than before the pH control was started. At least 2 factories, however, this year have had corrosion and at neither factory was any alkaline corrective agent being used to maintain the recommended alkalinity.

Furnaces

Fuel efficiency is now receiving more attention than heretofore. Many furnaces have been redesigned with larger combustion space and tuyeres have been added. The results have been well worth the expenditure. Furnace temperatures have been raised with resulting improvement in fuel economy and higher boiler ratings. In some instances fewer boilers are needed in service than previously, thus allowing ample opportunity for cleaning, inspection and repairs.

Imbibition Water Temperature

Information gathered on factory inspections shows that the majority of the factories are using fairly hot water at the mills. Six factories were applying water before the last mill at a temperature of 200° or over. Twenty-nine factories were using water at 150° or over, eight were below 150°, including one using cold water.

Mill Sanitation

Sanitation has been improved around the milling plants, thereby reducing undetermined losses through fermentation. One factory has done away with the conventional type of juice strainer and cush-cush elevator, and two other factories

have eliminated the elevators and all but short sections of the strainers. These devices have well served their purpose from the mechanical standpoint, but at best they are sources of fermentation loss through sour cush-cush accumulations. The elimination of these devices is now possible through the development of non-clogging juice pumps which have been perfected to the extent that at least three makes of such pumps are now giving satisfactory service.

Copper linings are being used in juice pans and troughs for preventing cush-cush accumulations. Sanitation is thus improved at comparatively small expense as the smooth surface in a large measure keeps the juice flowing freely and cuts down appreciable inversion.

The majority of our milling plants are now washed down regularly with hot water. A hose with a small nozzle using hot water under boiler pressure, and handled with a fair degree of intelligence, will accomplish a very efficient cleaning job with a comparatively small amount of water. The cleaning should be done twice a shift or about every six hours. There are still a few factories that are lax in their efforts toward keeping their milling plants clean.

Entrainment

Sugar loss by entrainment has received our particular attention this year. Factories that were formerly free from entrainment have increased their operating rate to the point that loss on this account is becoming large. Units with baffled calandrias are likely to entrain because of their greatly increased evaporative capacity. The greatest loss is from the last evaporator cell, the sugar being carried away in the condenser leg water.

Many factories test their various condensates with alpha naphthol for traces of sugar. This test, with fresh reagent, is reliable when the condensate is not diluted with condenser cooling water to too large an extent. In condenser leg pipes the condensate is diluted usually with 30 or more parts of cooling water to one part of condensate, and the mixture is too dilute to show any sugar loss with alpha naphthol even though sugar be present in appreciable amounts. For instance, alpha naphthol will give a "light trace" test in sugar solutions of 1 part in 10,000 to 1 in 100,000, but it is not always reliable at the higher figure and is of no value at greater dilutions. In a typical factory grinding 45 tons of cane per hour, producing 50 tons of mixed juice, using quadruple-effect evaporators, 80 per cent evaporation and 30 parts of cooling water to 1 part of vapor in the evaporator condenser, there will be about 650,000 pounds of leg-pipe water going to the sewer each hour. Now if there is only two-thirds of a pound of sugar lost per 100,000 of water, it will not show in the alpha naphthol test, but the loss will be over 4 pounds per hour, or about 100 pounds per 24-hour day.

A loss of 100 pounds per day or 4 pounds per hour in the above illustration is readily detected in making boiling down tests and polarizing the concentrated solution as described in our official methods of analysis. A 50 to 1 concentration with 0.1 reading in a 200 mm. tube will give, under the above conditions, 4 pounds of sugar per hour. One pound per hour loss could be detected by concentrating 100 to 1 and reading in a 400 mm. tube. The boiling down test is needed to determine

the actual pounds loss, if any. It is certain that any leg-pipe water, showing traces of sugar with alpha naphthol, should be concentrated and polarized, as the loss will be sufficiently high to require that preventive measures be taken to improve or install baffles or save-alls in the dome or vapor line.

In making these tests this year Mr. Elliott and the writer have found losses in evaporator condensers amounting to about 200 pounds per hour in 2 factories, and from 9 to 40 pounds per hour in several other factories. A loss of 40 pounds per hour with a 200-day crop amounts to nearly $6,000 even at low sugar prices.

Crystallizer Coils

Factories with water coils in crystallizers, as a means of more rapidly reducing the low grade massecuite temperature now number nine, and more installations are to be in use next season. A number of types of coils are used, but the type originally developed at Ewa is popular. With a cooling water temperature of about 72° F. (22° C.) and about 0.15 sq. ft. of coil surface per cu. ft. crystallizer capacity, the massecuite temperature is brought down to factory temperature in at least 2 days. With warmer water the coil surface should be 0.20 to 0.25 sq. ft. per cu. ft. capacity. By boiling the recommended grain of about 0.2 to 0.3 mm. length, there is usually no danger of false grain, even if the cooling water is started immediately after the crystallizer is filled.

After a massecuite has cooled rapidly there is supersaturation and the molasses has a higher viscosity than when saturated at the same purity. As a means of approximating saturation, three methods are in use. The first is by allowing a sufficient time interval to elapse for the molasses to give up its excess sugar to the crystals. The second is by slight dilution of the massecuite with water dripped into a scroll between the crystallizer and the mixer. A third method is by slight warming of the massecuite by circulating warm water through the crystallizer coils.

One factory has noted a more uniform cooling of the massecuite by increasing the speed of the crystallizer stirrers from the customary one revolution in 2½ minutes to one in a minute and a half. This factory installed coils three years ago, since which time the period in the crystallizer has been reduced from 8 or 9 days to 4 days, and this year the average gravity purity of molasses was 33.9.

Any factory without crystallizer coils that cannot reduce the temperature of the massecuite to approximately that of the boiling house when running at the maximum rate of grinding, should install cooling coils. The full benefit of the coils will not be realized unless centrifugal capacity is adequate to dry the massecuite at high density, but the coils are a means of practically doubling crystallizer capacity at comparatively small cost.

Heaters, Pans and Evaporators

Baffled type juice heaters are now in use at 26 factories. A new development in the Islands is the use of third cell vapor for the partial heating of mixed juice, the final heating to boiling being by usual methods. This method will be used at a second factory next year. New pan and evaporator installations are of the baffled

calandria type and old evaporator calandrias are being modified to the baffled type for greater efficiency.

Settlers and Filters

Dorr clarifiers are now installed in 8 factories and 35 per cent of our total juice is settled by this method. Two factories are, or next year will be, filtering all settlings with Oliver filters. One factory formerly operating the Petree process has for two seasons handled all settlings with Kopke separators, returning the mud to the fields.

Power Plants

A second factory will be equipped with a bleeder type turbine next year. One factory has just finished its first season with a 2500 K. V. A. turbine of this type which operated with perfect satisfaction. All power not required at the factory is used for operating irrigation pumps. These turbines can be operated at any optional exhaust pressure such as 6, 8, or 9 pounds, and all excess exhaust steam not required for maintaining the requisite pressure in the boiling house is condensed at high vacuum in a condenser below the turbine, thus securing a very satisfactory water rate.

International Sugar Congress—New Definition:

Pol, a coined word adopted for international use at the Third Congress of the International Society of Sugar Cane Technologists. Its definition and use, "The value determined by direct or single polarization of the normal weight in a saccharimeter. The term is used in calculations as if it were a real substance."

Improvement in Filtration Rate of Sugar by the Use of Phosphoric Acid

By A. Fries

Phosphoric acid and acid phosphates, in concentrated solutions or in dry or pasty form, have been used in the sugar industry to some extent for many years for the purpose of neutralizing excess of lime, or to hasten the precipitate of slow settling juices. As an aid to clarification its use in Hawaii has been limited. Clariphos, a concentrated solution of phosphoric acid, materially improved the appearance of the clarified juice of certain fields at Pioneer Mill fifteen years ago. S. S. Peck in the same year "obtained great assistance from a clarifier made by the Pacific Guano & Fertilzer Company," in his clarification of the separated mill juice at Kahuku. W. R. McAllep, in a report on clarification in 1923, wrote:

> The amount of phosphoric acid present is a very important factor, affecting the clearness of the clarified juice. With the ordinary clarification method, using lime and heat only, we have never obtained clear clarified juice with a deficient amount of phosphoric acid. On the contrary, we have never failed to secure clear juice by liming to the approximate point in the presence of a sufficient amount of phosphoric acid. Adding phosphoric acid to the juice has the same effect as if it were originally present.

Its use has been recommended by the Experiment Station and its advantage demonstrated during factory inspections.

In the following we wish to show that by the systematic application of soluble phosphates to the mixed juice, both filtration rate and color of the sugars can be improved at Honokaa.

The low filtrability and the poor washing quality of our sugars made it imperative that something be done in the sugar house, to effect an improvement. While changes in the clarification equipment, greater centrifugal capacity and speed, or the double purging would undoubtedly contribute to the production of a better sugar, we felt that if we could reduce by chemical means such material in our juices, which retard filtration, a higher filtration efficiency in the end product would be achieved. The use of phosphoric acid suggested itself. That the heavy precipitate of calcium phosphate improves an otherwise turbid juice, can easily be seen by the appearance in the test tube and is shown in a few laboratory experiments.

TREATMENT

Cane Var.	Mixed Juice Purity	—No Phosphate— pH, Hot	Clarity	— Phosphate — Lbs. per Ton Cane	ph, Hot	Clarity	Increase in Clarity %
Mixed	75.0	7.9	2.1	.66	7.8	2.7	29.0
Uba	75.6	8.0	1.1	.86	8.0	1.9	73.0
Mixed	75.3	7.8	2.5	.86	7.8	3.3	32.0
Mixed	78.0	8.0	2.4	.80	8.0	3.9	63.0
D 1135	78.9	8.1	2.3	.40	8.1	2.8	22.0
D 1135	82.6	8.1	2.3	.66	8.1	3.0	30.0
Uba	72.4	8.1	1.5	.86	8.1	2.4	60.0
D 1135	81.7	8.1	1.9	.54	8.1	2.2	16.0
D 1135	82.6	7.9	2.2	.60	7.9	2.7	23.0
D 1135	80.5	7.8	2.0	.54	7.9	2.7	35.0
Average	78.3	8.0	2.03	.68	8.0	2.76	36.0

Beginning July 15, 1930, Honokaa Sugar Company added phosphoric acid in the form of double superphosphate to *all juices* which were deficient in phosphoric acid and in such proportions as to bring the total P_2O_5 content up to .03 or .035 per cent. The benefits we have obtained in the factory so far are: Cleaner juices, higher syrup purity and better sugar.

The Refinery reports on two sugar shipments as follows:

First shipment, 1806 tons:

It is interesting to note that the Honokaa shipment on the *Mala* showed a marked improvement in filtrability. In comparison, the filtration efficiency of 68 per cent is 23 per cent higher than the figures of 45 per cent for the previous 1930 shipments from Honokaa. The washing quality shows a similar change.

Second shipment, 1557 tons:

The Honokaa shipment on the *Mana* ranked the highest in filtration efficiency for any 1930 shipments from this factory. This improved filtrability of the Honokaa raws has been particularly marked during the last three months, when the efficiencies have increased from 40.8 per cent for August to 68 per cent for October and to 72.5 per cent for this *Mana* shipment in November.

From the foregoing it is evident that the better clarification with the probable absorption of colloidal substances in the flocculent phosphate precipitate had its effect on the "refining quality" of the sugar. It is also evident from the laboratory figures during that period.

	No Phosphate	Phosphate	Difference
Cane per Hour	44.79	47.08	2.29
Clarity Readings	2.2	2.8	.6
Purity Increase from Mixed to Syrup	1.59	1.82	.23
Average Weekly Filtration Rate	40.0	71.0	31.0
Purity Final Molasses	37.99	36.75	1.24

Our good low grade work is, we believe, in some measure due to the improvement in clarification. The low syrup purity (77 to 80) put a heavy load on the capacity of the low-grade station. The high percentage of non-sugars considerably increased the low grade product of 65 to 70 purity and to make this in

marketable sugar, *all* strikes for weeks had to be boiled on syrup and remelt only, giving a crystallizer molasses of 54 purity. That these sugars showed marked improvement in both filtrability and washing quality is most noteworthy.

Four crystallizers were filled in 24 hours (23 per week), actual boiling time per crystallizer about 4½ hours, time for cooling, without cooling coils, from 4 to 4½ days, and yet, considering the difficulties we usually have in this station, we managed to purge all this low grade massecuite without any change in centrifugal capacity or speed, producing a final molasses of considerable lower purity. These results are so far interesting, as they confirm our opinion that it is unnecessary (and probably harmful) to boil a low grade strike for 20 or more hours; also that the cooling of the crystallizers to a very low temperature makes much greater demands on the centrifugal capacity, without adequate compensation for a lower molasses purity.

The cost for material so far amounts to about 15 cents per ton of sugar, or the equivalent of about 4½ pounds of sugar at present prices. We feel convinced that these 4½ pounds of sugar find their way into the bags in higher recovery from a better syrup and a better exhaustion of molasses. The above laboratory figures would indicate a .7 per cent higher recovery, equal to about 16 pounds of sugar per ton manufactured. We do not claim that such a plus recovery should be credited to a better clarification alone, however an increase in syrup purity of only .05, and a lower molasses purity of only .4 should pay for the extra cost of manufacture. As the P_2O_5 which has been added is recovered in the press cake and presents an available plant food, this fertilizer value of the calcium phosphate should be deducted from the cost of the material used.

Summing up, the practice of adding phosphoric acid to the juices might be recommended both from the standpoint of the raw sugar manufacturer and the refiner on all those plantations where there is difficulty in meeting the demands for a better refining quality of the sugars.

The Variety Problem in Australia

By C. G. Lennox

The problem of maintaining and improving yields through better sugar cane varieties has been more carefully worked upon by the Australian farmers than any other phase of sugar cane agriculture except, possibly, efficiency in cultivation. Both problems appeal more strongly to the creative imagination and are more easily visualized than complex soil amendment formulae or growth curve cycles. The result is that one finds nearly all the farmers keenly interested in both problems. The use of varieties has shown the farmer a cheap way to increase yields without any additional field expense. Their trial in the field offers something tangible, something the worth of which the farmer can watch and judge for himself. With this thirst for more varieties to plant in competition with their standard canes, it is little wonder that organizations and individuals turned to the simplest means, that of bringing in cuttings of recognized varieties from other parts of the world. This procedure was followed for more than fifty years without restrictions of any sort, and cuttings of more than 680 varieties have been introduced and planted in some one of the sugar regions. In addition to these introductions there has been an extensive exchange of sugar cane cuttings between different sugar growing regions. As a result of this unrestricted movement of cane cuttings, we find many of the world's severest systemic diseases securely established in the Australian sugar belt. The present-day variety problem is, therefore, very closely linked with the disease problem.

Importations

Prior to 1874 and until 1925, some 680 varieties were imported without restriction. The majority of these were brought in from New Guinea or neighboring South Sea islands. Other countries which have contributed are Mauritius, Java, Demerara, India, Hawaii, Louisiana and other sugar-producing countries. It is significant that of this great number introduced only a very few can be found at present, but these few produce approximately 75 per cent of the Australian cane tonnage. Badila (N. G. 15) alone produced approximately 45 per cent of the 1929 crop.

Importations at the present time are permitted only under strict quarantine measures. The Queensland Bureau of Sugar Experiment Stations at Brisbane and the Colonial Sugar Refining Company in Sydney are the only agencies handling the importation of cuttings from foreign countries. At Brisbane cuttings are planted in isolation gardens some distance from sugar cane regions and are not distributed until they have been carefully observed by the pathologist over some period of time. At Sydney, the Colonial Sugar Refining Company maintains gardens as well as an insect-proof greenhouse similar to the type used in Hawaii. New varieties are grown one year in this house before being released for planting in isolation areas in the regions at their mills in Fiji as well as Australia.

Breeding of Sugar Canes

As early as 1889, an organization known as the Queensland Acclimatization Society prepared to collect tassels for seedling propagation. Between 1890 and 1907, this Society raised some 1800 seedlings. The letter "Q" was attached to these varieties, of which there is one still in prominence known as Q 813.

W. Clark, working for the Colonial Sugar Refining Company at their Hambledon Mill, started to propagate seedlings about 1901 and continued through 1905 when he moved the breeding work to Colonial Sugar Refining Company mills in Fiji. This location was climatically ideal for seedling raising and with a good assortment of varieties from different parts of the world in his nursery he was able to make many crosses. The letters "H. Q." (Hambledon Queensland) are prefixed to the seedling raised at that station. The variety H.Q. 426 produced about 11 per cent of the Queensland sugar crop in 1929. The varieties H.Q. 409 on the Herbert River and H.Q. 5 in New South Wales have both become prominent in recent years because of their resistance to the gumming disease.

The work of seedling raising in Australia practically ceased between 1905 and 1921. At this time the Queensland Government Bureau of Sugar Experiment Stations started to propagate seedlings at their South Johnstone Station. The varieties produced here have the letters "S.J.Q." prefixed. At the time of the writer's visit in 1930, three varieties, S.J.Q. 4, 7, and 28, were showing considerable promise. Only S.J.Q. 4 and 28 were released officially to the farmers for propagation because all cultures of S.J.Q. 7 were infected with leaf scald.

Sugar cane breeding is at present being carried on by two separate agencies. The work for the Bureau of Sugar Experiment Stations is continuing at South Johnstone under the direction of Mr. Barke, the chemist in charge of the station. The technique used in crossing, as well as planting and germination, is very similar to that used in Hawaii. Germinated seedlings, as well as seed-bearing fuzz, are distributed to the government stations at Mackay and Bundaberg where the seedlings are planted in the fields and selected for the regions which these stations represent. A good collection of breeding material was planted in the Freshwater district near Cairns during the past season where weather conditions are more suitable for crossing work than they are at South Johnstone 60 miles south.

The Colonial Sugar Refining Company is carrying on a separate breeding project at its Macknade mill on the Herbert River. The work here is under the direction of K. Gard and the technique he follows is similar to that used in Hawaii. A portion of each year's crosses is planted in this region for selection and testing; the remainder is sent to Fiji and the Grafton Experimental Farm.

A third agency involved in the propagation of seedlings is the New South Wales Department of Agriculture. Seed-bearing fuzz is imported from different parts of the world and planted at the state government's experimental farm at Grafton, a point about fifty miles south of the most southern sugar cane region. Selection work is carried on here in cooperation with the Colonial Sugar Refining Company officials at Broadwater.

Selection and Testing of Seedlings

The early stages of selection work are all carried on at the experiment stations or in the mill nurseries. Following the first selection from the seedling stool, all further selections are based largely on juice quality. Varieties of low juice quality are quickly rejected. All seedlings raised by the above-mentioned agencies which reach the final stage in field tests are planted in a gumming-disease test before being released to the farmers. The seedlings showing susceptibility are not released.

Variety Tests

Practically no use has been made of replicated variety tests in the field to determine the superiority of one variety over another. Changes in variety have been due largely to disease in old varieties, reputation of new varieties or appearance of a couple of lines of a new variety growing alongside the old variety. The difficulties of carrying on reliable variety tests on a small farm are many, but within the past few years the Bureau of Sugar Experiment Stations has successfully installed a few tests in the "Latin Square" plan.

Commercial Planting of Varieties

The farmer is not free to plant any variety he may choose. He can send to the mill only those varieties which are listed as approved for his region by the Central Board (a board representing the government, millers and farmers). This control of plantings has arisen to protect the factories from receiving expensive milling canes of low quality and to protect the industry as a whole from severe disease epidemics by not allowing the planting of very susceptible varieties. Should a farmer send a disapproved variety to the mill it may or may not be accepted, depending on the management's decision. This policy of controlled variety planting has created two distinctive features in the variety situation today which would not likely be found if it was not in force. In the first place we find the whole Australian sugar crop coming from a comparatively few varieties, a condition not likely to exist in an agricultural crop coming from small non-organized yeoman units. Secondly, we find a yearly bettering of the juice quality for the whole crop, but no betterment of tons cane per acre.

The following table represents the per cent of the total crop produced by the different major varieties grown in Queensland. These figures were furnished by the Chairman of the Central Board and do not include figures from New South Wales or Colonial Sugar Refining Company mills:

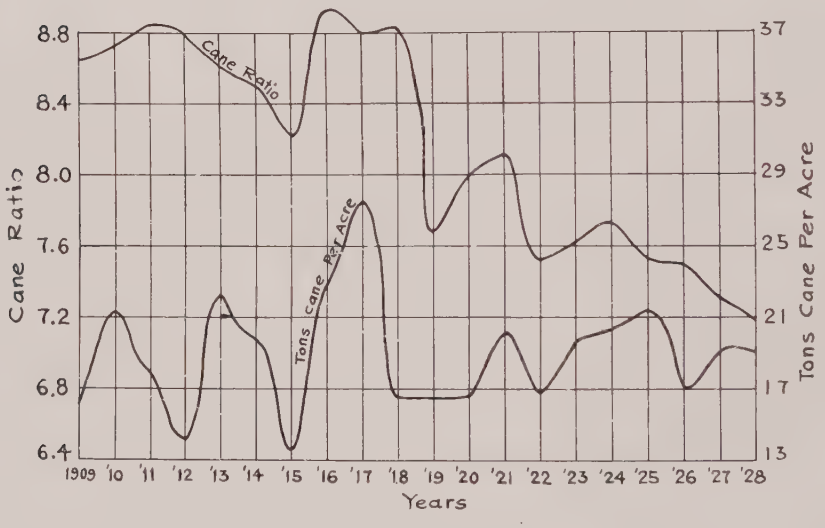
District	Badila	D 1135	H.Q. 426	Q 813	M 1900	E.K. 28	Other Varieties
Cairns & Innisfail.....	84%	4%	6%	..%	..%	..%	6%
Lower Burdekin	39	..	22	1	2	19	17
Proserpine & Mackay...	15	3	17	22	20	6	17
Bundaberg & Isis.....	3	33	..	13	14	..	37
Maryborough & Nambour	2	28	..	32	7	..	32
All of Queensland.....	45%	8%	11%	8%	7%	5%	16%

The following table details the varieties in order of importance which are grouped in the above table as "Other Varieties":

District	Varieties
Cairns & Innisfail	Pompey, N.G. 24
Herbert River	H.Q. 409, Badila, Oramboo, Nanemo, Korpi, Q 813, M 131, N.G. 24, M 1900
Lower Burdekin	B. 208, Oramboo, N.G. 24, Pompey
Mackay	Malagache, P.O.J. 2714, Pompey, H.Q. 285, B 208, Uba
Bundaberg	Uba, P.O.J. 2714, H 227, Many others.

The following graph shows clearly the second influence of controlled variety planting, that of improving the juice quality of the crop as a whole. It is to be noted that although the cane ratio improves, the tonnage of cane per acre shows no gain. The premium offered by the mills for high sucrose cane is so attractive that the farmer is constantly striving to crop only varieties of the highest sucrose content even if their per acre yield of cane is a little lower.

Yearly Average Cane Ratio and Tons Cane (short tons) Per Acre For The Australian Cane Sugar Crop



The high juice quality of the Australian sugar cane crop has always been a matter of considerable interest. The reasons for this have been partly covered in the above discussion, but these factors, namely, enforced planting of high sucrose varieties and a higher scale of payment for cane of high sucrose content, have only aided in improving an already good sucrose average. The greatest factor may be considered the weather conditions which accompany the harvesting season which is characterized by little rain and low temperature. Other influencing factors may be a reduction in fertility of the land (for little is returned in proportion to the amount removed) and increased milling efficiency.

The following table gives the performance of a few of the main varieties during the 1929 milling season. The mills are representative of the sugar areas from Mackay to Cairns:

	Mulgrave Central		Babinda Central		Mourilyan Mill		Pioneer Mill		Racecourse Coop.	
Variety	% of Crop	Av. Q.R. for Crop	% of Crop	Av. Q. R. for Crop	% of Crop	Av. Q.R. for Crop	% of Crop	Av.Q.R. for Crop	% of Crop	Av. Q.R. for Crop
Badila	68.6	6.64	88.04	6.58	94.9	6.38	27.5	6.45	...	...
D 1135.....	14.1	6.63	.40	7.22	...	...	...	...	1.3	6.97
B 147.....	5.3	6.64	.09	6.27	...	...	...	...	...	...
H. Q. 426.....	10.7	6.08	7.96	6.44	2.7	6.58	26.1	6.55	25.	6.31
Goru (N.G. 24)..	...	...	1.21	6.57	...	...	3.9	6.73	...	...
Q 813	...	...	.48	6.39	.16	6.52	...	...	31.9	6.37
M 1900	...	...	...	...	...	...	...	...	17.2	6.65
E. K. 28.....	...	...	.01	8.54	...	...	22.5	6.66	7.2	6.41
Pompey (7R 428)	...	...	...	...	2.05	7.31	...	...	1.3	7.2
B 208	...	...	...	...	.03	6.25	11.	6.12	...	...
Uba	...	...	...	...	...	...	...	...	.21	7.14

Note:—The Q.R. figures used are the reciprocals of the Commercial Cane Sugar figure used in Australia.

Australian Varieties of Interest to Hawaii

A task which would border on the impossible would be for one to pick varieties of sugar cane which may be superior in Australia and expect them to be also superior in Hawaii. The growth conditions for the two places are totally different. A superior cane in Australia is one which can make the most of a short intensive six months season of growth and be ready to harvest about twelve months after it was started. To ask a cane to carry through two growing seasons in Queensland would be fatal; in Hawaii it is expected. Besides this single big difference there are many others, as: upright cane vs. recumbent, long periods of dormancy of ratoons vs. immediate starting of ratoons, non-burning before harvest vs. burning before harvest, resistance to disease vs. no presence of same diseases in Hawaii, and many such minor points of difference that a variety chosen as superior in the one place would likely not continue to be superior in the other. With these considerations in mind it is quite impossible to think that any of the better varieties there will do wonders here. The writer believes the following would have some interest if imported to Hawaii:

B 208, considered the "sweetest cane in Australia," big stick, closes in well, germinates and ratoons well, rarely tassels. Possibly of commercial value but very interesting for breeding purposes.

H.Q. 426, generally sweeter than Badila, big stick, considered good on medium to poor soils, germinates well, but closes in rather slowly. Rarely tassels. Early maturer. N.G. 24 (Goru) is female parent. Possibly of commercial value. Blood line well represented in seed brought from Australia in 1930.

Summary

The insect and disease problems in the Australian sugar industry are living examples of the results of importing sugar cane cuttings from all countries of

the world without restriction. Importations are now permitted only under rigid quarantine.

The breeding of sugar cane seedlings was spasmodic for twenty years. Within the last few years an organized effort has been made to start a breeding and selection program.

A system of controlled planting of only approved varieties of high sucrose content as well as a higher rate of payment for cane of high sucrose content has tended to increase the juice quality of the whole crop.

The 1929 season's Quality Ratio figures from five representative mills show H.Q. 426, B 208 and Q 813 to average better in juice quality than Badila.

The Forests of Siam

By L. W. Bryan

The following article is taken in part from data supplied by the Siam Royal Forestry Department and from notes taken by the author during his recent trip to that country.

Roughly speaking, Siam covers an area of about 200,000 square miles, and of this area about 60 per cent is covered with tree growth of some kind. The climate is tropical, the northern latitude being 21 degrees (about the same as Kauai), and extends south to 5 degrees north.

Teak Forests

The teak forests are the most valuable and important of all the state forests and cover an area, in the northern part of the kingdom, of about 11,000 square miles. This teak section is hilly and mountainous in places, although the highest mountain in Siam is only 8,500 feet above sea level (Mt. Angka). Teak in Siam, however, does not grow up to any elevation, about 2,500 feet above sea level being the limit of its range.

The average rainfall in the teak section is about 50 inches per annum, and the species *Tectonia grandis* seems to grow best in soils derived from granite, sandstone and limestone and must have good drainage. While young it is rapid in growth, but soon slows up so that during middle life and old age it is very slow and takes about 150 years to produce a trunk three feet in diameter. The largest teak tree known in Siam is 10 feet in diameter (breast height), and 150 feet tall. Teak does not form large areas of pure stands, but is often found mixed with other trees, a number of which are trees that produce merchantable timber of considerable value, such as *Pterocarpus indicus, P. macrocarpus, Lagerstroemia calyculata* and *L. balansae*. The wood of these species will float under certain conditions and can, therefore, be cheaply transported along with the teak by water, while the heavier woods, that will not float, must be left behind in the forest.

All of the State teak forests are under the control and administration of the Royal Forestry Department. This department is a well-organized branch of the government, coming under the control of the Minister of Agriculture, with well-trained foresters who have entire charge of all leases and cutting operations on the government-owned properties. In the teak zone there are six forest divisions, each in charge of a division head.

At present there are twenty-eight leases in force to cut teak. These leases run for fifteen years and are subject to the following conditions:

1. All trees to be cut must be selected and girdled by employees of the forestry department.

2. No tree with a girth of less than 7 feet can be cut, and 6 per cent of the best trees are reserved for seed trees.

3. Metric measure is used and charges are based on measurements made by the forestry department.

4. All trees must be cut close to the ground in order to eliminate waste.

5. Certain valuable trees, other than teak, have been placed in a reserve class and are protected by a royal decree and can only be cut under special permit.

Trees in the unreserved class (usually species of an inferior type) can be cut without restriction, and free permits are issued to local people to cut certain reserved trees for home use, religious or charitable purposes.

About 85 per cent of the teak forests are worked by foreign firms. The Brandes Selection System of management is in use and the falling cycle has been set at thirty years (which is the number of years required for the smallest tree in the girth class below that of the exploitable girth [7 feet], to grow and become of exploitable size). The trees to be felled are first selected, measured, numbered and then recorded by the forest officer in charge of this work. Then it is girdled by cutting a ring about 4 inches wide around it through the bark and cambium. This kills the tree slowly and each tree is girdled about two years before felling time. This is done in order to permit it to dry out and become seasoned. Practically all of the teak timber is brought from the forests to the seacoast and mills by floating it down the rivers. Green teak logs are too heavy to float, so it is first necessary to season and dry the trees before felling.

The actual felling is done with saws and axes in much the same manner as here and elsewhere. All trees are cut as close to the ground as possible and are then cut up into logs of suitable lengths and marked with their owner's brand or identification mark. All felling is done during the rainy season when the ground is soft and less likely to damage a falling dry tree.

Trained elephants are used to skid the logs from the place of felling to the river bank. This operation also takes place during the rainy season when the ground is wet and slippery and the logs slide more easily. The elephants used are well trained and are reputed to be the most intelligent draft animals in the world, and from what the writer saw of them this is believed to be true. They are expensive to maintain, however, and are easily injured, so in some sections they are being done away with and replaced by more modern methods.

The logs, after entering the water, are driven down stream in much the same manner as on our own mainland. After they have been driven down the smaller streams, past all rapids and "white water" into the larger rivers, they are sorted out according to their brands, and each firm's logs are rafted together and floated down to the seacoast or other destination. These rafts contain about 200 logs each and it requires about five years from the time a tree is felled before it reaches its final destination at the seacoast. Some logs are transported in other ways, but the large cut is handled by water.

Upon arrival at the Forest Duty Station the logs in the rafts are measured and dues are collected. The logs are then graded; some are sold, while others are taken on to different sawmills, where they are cut up into dimension material, the best of which (about 55 per cent) is exported. The annual amount thus exported is about 2,500,000 cubic feet.

Teak is considered one of the most valuable timber trees in the world. It is used for all sorts of purposes and is considered the finest of shipbuilding material. It contains little sap wood and the heart wood contains an oil which is its chief preservative. When new it is dark golden yellow, but with age becomes almost black. It is very durable and has been known to last from 500 to 600 years when used in buildings. It is one of the few tropical trees that produce annual rings.

In addition to the teak forests there are several other types, such as evergreen forests, deciduous forests, coniferous forests, mangrove swamp forests, and others.

Evergreen Forests

The evergreen forests are scattered over Siam and consist of two types, the tropical evergreen and the hill evergreen. The former grows up to about 3,000 feet elevation, where it is replaced by the hill type. This hill type, as a rule, is thick and impenetrable and is little known or explored as yet and has practically no commercial or economical value at present.

The tropical type, however, is fairly well known and produces much of value. It is made up of many different species, several stories high, which form a thick, often impenetrable, jungle. The family Dipterocarpaceae, is well represented by many species which are found throughout this type and produces a large percentage of the best timber. Several other species occur that also produce valuable wood, such as Dalbergia spp., *Mesua ferrea, Diospyros mollis, Afzelia bakeri, Cotylelobium lanceolatum,* Lagerstroemia spp., *Mansonia gagei, Aquillaria agallocha,* etc.

The logging operations in this type of forest are much the same as in the teak forests and are under the control of the forestry department. In addition to sawmill material, other products are obtained from this type.

The Royal Siamese Railroad burns wood in its locomotives on the southern division and consumes some 120,000 cubic meters each year, a large part of which comes from this type.

Bamboos and canes are also utilized, and quite an export trade has been built up.

Gutta-percha, as well as other gums, oils and resins, is also obtained from this type of forest in commercial quantities, all of which are gathered and a large percentage exported.

Coniferous Forests

The coniferous forests are located in northern and central Siam above 2000 feet elevation and are composed chiefly of two species, *Pinus khasya* and *P. merkusii.* At present they are too isolated to have any commercial value although a small amount of resin is gathered and used locally.

Mangrove Swamp Forests

There are some 300,000 acres of these swamp forests in Siam located along the seacoasts and made up of a limited number of species suitable to this type, the most important family being Rhizophoraceae, to which the true mangrove (Rhizophora spp.) belongs. That most useful palm, *Nipa fruiticans,* is also found grow-

ing in this type of forest. Good timber is secured from *Ceriops candolleana, Carapa moluccensis* and *C. obovata,* while small to medium-sized saw logs are secured from two species of the true mangrove, *Rhizophora conjugata* and *R. mucronata.*

Fuel and charcoal are also produced in large quantities and it is here that the trade in these products has reached its greatest development in Siam.

Mangrove barks are also gathered and exported in large quantities. They are used for tanning and dyeing purposes.

Deciduous Forests

These forests, which are known locally as "Pah Peh," occur in different parts of the kingdom and contain many species of valuable timber-producing trees. They are open in type with grassy undergrowth, subject to repeated ground fires, and are deciduous during the dry season, when they drop their foliage. Here, again, the family Dipterocarpaceae produces a large part of the worth-while timber. Cutting is done under government control in most sections, based on the royal decree of 1914. Under this authority all trees are divided into two sections, (1) unreserved trees, and (2) reserved trees.

Anyone can fell and use trees in the first section. Those in the second section are divided into three divisions, (a) very valuable trees which may not be cut at all, (b) valuable species of trees, and (c) less valuable species of trees. Minimum girths for reserved species are set by law and those wishing to cut trees in divisions (b) and (c) may do so by first securing a permit and paying certain fixed royalties. This also applies to any by-products obtained from trees in these divisions, such as gums, oils, resins, etc. Permits are not issued to cut trees in division "a" as these trees are considered too rare and valuable and are being retained for propagation purposes.

Diseases of the Avocado

By C. W. Carpenter

The diseases of the avocado have received comparatively little attention from pathologists in Hawaii. This introductory paper on the subject was presented in abbreviated form at the Third Annual Meeting of the Avocado Association of Hawaii, November 25, 1930, at the invitation of Dr. W. D. Baldwin. The material is largely an interpretation of the literature as it seems to apply to our local industry. Critical studies of the local avocado diseases, which should serve as a foundation for an authoritative discussion of the subject, have not been made. If this paper serves in any degree to clarify the confusion that exists in the subject of avocado diseases, its purpose will have been fulfilled.

In Hawaii, the various spots and blemishes of the avocado fruit have not been clearly differentiated or the causes ascertained with sufficient accuracy to be of much value. The literature from other countries is often not accessible and offers too much confusion of names of diseases and causal parasitic organisms to be readily useful to the avocado grower. A similar condition prevails with the diseases of the leaves, branches and trunk of the tree.

This discussion of local avocado diseases is chiefly concerned with those caused by parasitic fungi, yet mention will be made of certain blemishes of other origin which are likely to be met by the growers. A few remarks about the nature of

Spores of avocado black spot fungus. X 320.

fungi are necessary to a simple and brief discussion of fungous diseases. The fungi concerned are minute plants with the general characteristics of the molds often seen on bread or vegetables stored in damp places. There are an almost infinite number and variety of these fungi, differing in habit of growth and manner of fruiting. The great majority obtain their food from dead organic matter, a considerable number live at the expense of living or dead plant material as occasion requires, while relatively few are strictly parasitic. The fungi are propagated and spread chiefly by microscopic spores (see illustration), which are comparable to the seeds of higher plants. These spores, formed in countless numbers under favorable conditions, are responsible for the rapid spreading of fungous diseases, since they are readily carried by wind, spattering rain, garden tools, etc.

If one considers the descriptions of avocado diseases from various localities, the local names applied are very confusing. Of the semitechnical names, the term anthracnose has been much abused. This name indicates a disease or blemish of pustular or ulcerous type and has been so loosely used as to have little significance. It is commonly used, however, for the numerous diseases caused by the fungi known as Colletotrichum and Gloeosporium, two practically identical groups of fungi. In the literature the following diseases of the avocado are discussed separately with distinctive names for each trouble according to the part of the tree affected, or the parasitic fungus suspected: anthracnose of leaf, leaf blight, rusty leaf blight; anthracnose, die-back and wither tip of branches and fruit spurs; blossom blight, black fruit spot, bark rot and canker or girdling of branches and trunk. Yet all appear to be caused by very closely related species of Colletotrichum or Gloeosporium, the anthracnose fungi. Reasons will be presented below for considering this formidable array of diseases as the manifestations of one fungous disease on various parts of the avocado tree. Until the contrary shall be demonstrated, it simplifies the subject considerably to adopt this viewpoint.

A similar confusion long existed with respect to the various manifestations of the similarly named diseases of the apple—the black fruit spot, leaf spot and canker. It is now recognized that in its various stages this apple disease affects (1) the fruit, causing blemishes and rot; (2) the limbs and twigs, causing blight and die-back; and (3) the leaves, causing the spots known as "frog eye". The fruit rot first claimed attention and was described by various names, as for example: black rot, ring rot, blossom-end rot and brown rot. On the bark the disease was described as die-back, twig blight, apple canker, black rot canker, black rot, and New York apple tree canker. On the foliage the disease was termed leaf spot, leaf blight, brown spot and frog eye. Various fungi found on leaf, twig and fruit were held responsible for the respective diseases. Finally one fungus was determined to be the cause of the several forms of disease and it was considered to be the species named *Physalospora cydoniae* Arnaud. The genus Physalospora represents the higher fruiting stages of the genera Gloeosporium and Colletotrichum.

The analogy of the history of black spot and canker of apple and of avocado is close. It does not appear presumptious to predict that in this same way the Hawaiian avocado diseases, black spot, leaf spot, die-back or wither tip and bark canker, will be ultimately demonstrated to be due to the single fungus, *Physalospora persea* Doidge. This fungus, already determined elsewhere as the higher stage of

the avocado Gloeosporium or Colletotrichum, is closely related to the apple Physalospora, above mentioned.

Brief extracts of the descriptions, by various authors, of bark canker, leaf spot and black rot, as well as of several other fruit spots, are presented below. The probability that the symptoms of the diseases may be somewhat different on the several varieties of avocado should be appreciated.

Bark Canker, Leaf Spot and Black Spot of Fruit

Doidge (1) describes the bark cankers of avocado as they occur in the Louis Trichardt district of the Transvaal, South Africa, as follows:

> In the earlier stages of infection the bark becomes sunken and discolored, the diseased area gradually increasing and girdling the branch. Small branches, not exceeding two to three inches in diameter, are killed, while extensive cankers are formed on the larger limbs and trunks. The boundary between the healthy and diseased tissue is marked by a raised, reddish-brown line . . .
>
> The mycelium penetrates the cortical tissues and reaches the wood, where it is apparently confined to the medullary rays.
>
> The disease can probably be arrested in its early stages by excising all diseased twigs and stem cankers, and painting the wounds with a disinfectant wound dressing.

The following description of black spot of avocado fruit is quoted from Stevens (2).

> The injury appears as definite spots scattered over the surface of the affected fruit. These spots are round, brown to dark brown or black in color, and vary from one-eighth to one-half of an inch in diameter. They are composed of hard, dry, corky tissue which penetrates the skin of the fruit down to the meat.
>
> The surface of a spot is slightly sunken, often cracked or fissured, and in some cases a zonated effect is observed. When once formed, the spots do not appear to increase in size on the surface of the skin, but a decay of the meat below may follow, especially in matured fruit. Affected fruit may show a few or many spots of various sizes. Frequently, spots merge to form irregular patches, the surfaces of which are deeply cracked or broken. Severe attacks on less matured fruit may misshape or dwarf them.
>
> Spots also appear in the bark of young shoots and on fruit stems somewhat similar to the spots on fruit. Infections on the fruit stems generally appear some time in advance of those on the fruit.

A description, probably of the same fruit spot, is given by Abbott (3) under the title "Anthracnose of the Avocado in Peru." This paper presents a comprehensive description of the "anthracnose" as one disease affecting various above-ground parts of the avocado tree. The anthracnose is attributed to *Physalospora persea*. Three paragraphs are quoted:

> Anthracnose may attack any of the above-ground parts of the tree, but its most serious damage is caused when the main trunk and fruiting branches are involved. On these organs the infection begins as a dark reddish-brown area, which enlarges gradually, usually more rapidly horizontally than vertically, until it forms a lesion which eventually girdles the affected part. The canker is at first sunken, especially in young, tender tissue, but as the disease advances the bark dries, cracks and buckles out, giving the affected portion a bulged appearance. The dried bark sloughs off and the limb dies slowly. The sap of the tree flows out

through the cracks in the bark and on drying leaves a whitish, crystalline substance, the presence of which is characteristic of the disease. The fungus has not been observed penetrating into the woody portions of the trunks or limbs, the infection apparently being limited to the cortex.

On the fruit anthracnose produces round, sunken, reddish-brown spots which are usually from one to two centimeters in diameter. The centers of the fruit lesions may be pale pink in color caused by the production of spores of the fungus. As a rule the decay does not extend deeply into the flesh of the fruit, although the diseased spots offer ideal means of entrance for other fungi, particularly *Rhizopus nigricans*, which may cause more rapid decay of the fruit than the anthracnose itself. The decayed areas have only rarely been observed penetrating to the seed.

On the leaves the disease causes circular, chocolate-colored spots. Infected blossoms may turn black and fall. Leaf and blossom infection, however, is of secondary importance compared with the damage which is caused to the tree by the destruction of the trunk and branches and the rotting of the fruit.

The avocado fungus probably gains entrance to and infects the flowers, the young twigs, fruit spurs and the leaves under favorable weather conditions and also enters small wounds or sunburned places on the branches and trunk. This fungus is said to be a weak parasite which possibly requires some predisposing factors to favor its entry, such as lowered vitality from overbearing, malnutrition or poor drainage. Favoring conditions are wet weather at flowering time, sunburn injury, wounds of fruit and bark, etc. Both the avocado and mango appear much more susceptible at flowering time, especially if high humidity and heavy dews or rainy weather prevail.

The remedial treatments most commonly suggested for the control of this disease are those sanitary measures designed to prevent infection. The following measures are recommended (a) maintenance of a clean orchard—infected limbs being pruned out and burned; (b) frequent spraying with Bordeaux mixture, especially at flowering time; (c) frequent disinfection of pruning tools and treatment of wounds with lead paint, Bordeaux paint or other disinfecting wound preparations, as seals; (d) avoiding injury to the fruit and to the bark of limbs and trunk by ladders and implements; (e) frequent inspection of trunk and limbs for early infections of bark canker; (f) when bark canker is located on large limbs or trunk, cut away infected bark to healthy tisue, disinfect and coat with disinfectant paint or other seal to prevent reinfection until nature heals the wound by the gradual overgrowth of cambium; (g) for prevention of sunburn of limbs and trunk, which seems to favor canker, the advisability of spraying the exposed parts with a protective coat of whitewash as is done with apple trees in the dormant season, might be considered.

Dr. Baldwin has observed that where avocado fruits hang in such a position as to come in contact with other fruit or branches a black rot spot results in a great many instances. He has reported it as economical to prevent such contacts by removing small branches and rearranging the natural "hang" of the fruit. In spite of the fact that this rather laborious procedure must often be done over again, following heavy winds, he has found it a valuable supplement to spraying with Bordeaux mixture. The general restriction of the occurrence of black fruit spot to the point of contact of fruits with each other or with parts of the tree,

indicates that the fungus may be primarily a wound-invading organism, in contrast to the more aggressive parasitic fungi.

Avocado Blotch

Avocado fruit spotting or blotch as described by Stevens (2), pp. 17-21, resembles the avocado blast discussed by Smith (4). The avocado blotch is said to be caused by a species of the fungus known as Cercospora, while blast is caused by the same species of bacteria which causes citrus blast. Either one or both diseases may be present in Hawaii but they have not been properly identified. The following description is quoted from Stevens:

> Blotch is a surface spotting of seedling avocado fruit which is most noticeable as the fruit approaches maturity. The first spots may occur when the fruit is less than half grown, after which a succession of spots will follow until the surface is nearly covered. Mature blotch spots appear as small, slightly sunken, irregular blotches on the surface of the fruit, usually black in color, but often showing short, white fungous growth at the centers.
>
> Fully developed blotch spots may vary from one-eighth to one-fourth of an inch in diameter. The beginning of such a spot is indicated by a pale green area, showing one or more brown or black dots which are smaller than a pin's head. Gradually the pale green area becomes brownish to black in color, and eventually develops into an irregular sunken pit or spot which is typical of the disease. These spots may be scattered freely over the surface of the infected fruit, or several may merge to form irregular black patches. The spots are confined chiefly to the rind of the fruit, but more advanced stages may penetrate into the edge of the meat. The interior of a spot is composed of brown, spongy tissue made up of dead, collapsed cells of the fruit rind, intermingled with the dark-colored mycelium of the fungus. The disease is confined apparently to the fruit. However, in a few cases the fungus has been found in spots on fruit stems similar to those on the fruit.

Avocado blotch is said to be controlled by Bordeaux sprays as used for anthracnose or black spot.

Avocado Blast

The following description of avocado blast is quoted from Smith (4):

> The fruit exhibited a marked cracking, which was the most severe near the blossom end. In addition to the cracking, definite brownish, or more often black, irregular or nearly circular spots were found which were situated near or surrounding a lenticel. The disease is superficial, being limited almost entirely to the rind. In the older spots the tissue about the lenticel has become torn and the margin appears somewhat elevated, as if ruptured. The spots are slightly if at all depressed. They are variable in size from the younger stages, when the beginning of the spot is just visible, to a mature spot that may measure from one-eighth to one-quarter inch in diameter, or even larger by the coalescence of several spots. The cracking of the fruit is believed to follow a severe spotting (infection) of the fruit, as this condition would allow the tissue to dry out.
>
> The cause of the trouble, as has been indicated, has been found to be a species of bacteria that was first described as causing a spot on lemons known as "black pit."

Varieties are said to vary in susceptibility, Knight being most severely attacked and Fuerte very slightly.

Avocado Scab, Russet Fruit, Carapace

The three blemishes of fruit called avocado scab, russet fruit and carapace spot are characterized by a roughness of the skin of the fruit.

Avocado Scab:

Avocado scab may not occur in Hawaii. It affects both foliage and fruit. The disease is said to attack only young and tender growth. The injury to fruit is superficial, marring the appearance but not affecting the quality. Again quoting from Stevens (2):

> The spots (on the leaves) are generally small, circular to irregular in outline, and vary from one-sixteenth to one-eighth of an inch or more in diameter. They are purplish brown to dark in color and may appear scattered over the surface or several may grow together to form irregular areas. . . .
>
> On the young shoots, twigs and leaf petioles the spots appear darker and more elevated. . . . On the fruit occurs the same oval-shaped, raised type of spot that is found on the twigs. The spots may be scattered or clustered together to form an irregular scabby mass.

Avocado scab is said to be more prevalent in young plants in the nursery. Timely applications of Bordeaux mixture are reported to be beneficial as a control procedure.

Russet Fruit:

Russet fruit is variously attributed to mechanical abrasion of young fruits by the foliage. Thrips, mites and fungi have been mentioned as causes. Locally the russet blotches and bands of russeting or occasional "ring neck" apparently have not been satisfactorily explained. Much of this type of blemish appears to be due to foliage abrasion and other injuries when the fruits are small.

Carapace Spot:

Horne (5) has described a rough, cracked, superficial skin blemish which resembles a turtle's back. On account of this resemblance this blemish was named "carapace spot." The cause is undetermined but Horne suggested that this blemish may be due to slight skin injuries of the young fruit, which do not visibly scratch or break the skin.

Red Spider

The red spider, or leaf mite, is a troublesome pest of avocado foliage, especially in sheltered locations in the dry season. Defoliation as a result of red spider infestation permits sunburn injury of fruit, and besides, is harmful to the tree in reducing its vitality and possibly preventing normal bud formation and setting of fruit. Sulphur dusts or sprays and oil sprays have been found useful in checking this pest.

Conclusion

In conclusion, the local avocado disease situation may be summarized as follows: The anthracnose of leaf, fruit, branches and trunk is the most troublesome

fungous disease with which the grower has to contend. Frequent spraying with Bordeaux mixture, adjustment of fruit to prevent abrasion, and the maintenance of a clean orchard are the best means of control. Cankered or dead branches should be removed and burned as soon as they are detected. Cankered spots on the trunk should be cleaned out to undoubted sound bark and wood, disinfected and sealed with disinfectant paint, wax or tar; and possibly other measures taken to assist the closing of the wound. Pruning tools should be disinfected frequently and pruning wounds painted. Sunburn injury of fruit and branches should be prevented. It is thought that the choice of a locality with a deep, well-drained soil, adapted to the variety, will assist materially in insuring a vigorous growth, resistant to diseases.

Several additional diseases or blemishes described in other countries may occur here but they appear to be relatively unimportant and the sanitary measures used for anthracnose or black spot should also tend to control them.

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Java's Sugar Industry

By W. van H. Duker

Introduction

Anyone visiting the Dutch East Indies and particularly Java, will probably be most impressed by the enormous number of people everywhere, the quietness, order and cleanliness of the population as a whole, and the high state of agricultural development of the land. Van Dyke, in his book on Java, says:

> There is every sign of prosperity or at least of physical well-being notwithstanding the congested condition in many sections. The native is an excellent farmer; he spares neither himself nor his wife nor his children in keeping the crop growth at its maximum. They all work. The Dutch administration lends a powerful hand and early realized that the imposition of foreign ideas upon a country or a people is always a questionable proceeding. They are usually not suitable and often meet with native opposition for no other reason than that they are foreign. The Dutch have learned this from experience and are now disposed to accept local conditions. They are protecting the native and allowing him to develop along his own lines. They are not trying to change him into a Dutchman, they do not ask him to wear Dutch shoes, shirts or hats, but allow him to go his own way, barefooted and in sarong.
>
> His religion, customs and traditions are respected, he is protected in his land and helped in his agriculture and the Dutch government recognized from the beginning that the first item in the economic program is that the native shall have enough to eat and they have spent millions on the land to that end. Largely, perhaps by reason of this liberal and general policy in administration, the Dutch have proved themselves the most successful colonial administrators of modern times.

The island of Java is situated between the 5th and 8th degrees south latitude and the 105th and 114th degrees east longitude. The area is 48,688 square miles and the present population is around 40,000,000 with an annual increase of 260,000.*

History

The finding of a sea route to the East Indies in 1498 and the consequent shifting of trade routes had a stimulating influence on the cane sugar cultivation in Java. Soon thereafter, both the East and West Indies became the principal export countries for sugar, taking the place of countries around the Mediterranean Sea.

It is not known just when the sugar industry started in Java, but a Chinese traveller, who visited Java in the year 400, mentions the presence of sugar cane in Java as something that he apparently did not expect to find there.

The first Hollanders, who landed in Java in 1595, found sugar marketed at Bantam, brought in from near-by places. The entrance of the East India Company in the Orient opened up a new era. They, themselves, were not particularly

* The island of Hawaii = 4,015 square miles; the island of Oahu = 598 square miles. The total population of the Hawaiian Islands is around 350,000.

interested in the development of Java as a sugar-producing country, because their business was that of the trader, but they compelled the Orient in general and Java in particular to supply products which they could sell profitably in the European market.

For the next two centuries the sugar industry developed but slowly on account of the uncertainty of the demand in the European market, the frequent changes of administration, and the consequent differences in economic policies.

In 1830, an entirely different and rather unique system of agricultural production was introduced, known as the "cultural system."

According to old Java traditions, the sovereign was the owner of the soil, who gave it to the native farmer in exchange for a part of the returns as well as for a certain amount of compelled labor on roads, bridges, etc. The Dutch government reasoned that they had replaced the native sovereign and were, therefore, now entitled to the same privileges, and proceeded to force contracts upon the native farmers, whereby the latter were compelled to give up one-fifth of their rice land for the cultivation of products in demand on the European market.

With cotton, coffee, tea, etc., this was a comparatively simple affair, but with sugar it was different, and separate agreements had to be made for its extraction in sugar mills. At first only Chinese took it up, but after the profitableness became more generally known, the Europeans followed.

The sugar industry then developed at a rapid rate. With a production of 14,850 short tons in 1835, it reached 92,800 in 1868. The yield per acre increased from .9 ton to 1.85 tons.

However, on account of mismanagement and ill use of the native labor, political pressure in Holland, etc., the cultural system was abandoned in favor of free labor and open competition by law adopted in 1870, providing, however, for a gradual withdrawal of governmental interference with the industry, which was to cease altogether in 1892.

During the period following, that is, from the crisis in 1884 caused by the rapid increase of the beet sugar industry in Europe and the damage wrought by the Sereh disease, the sugar industry passed through a number of very trying years with a turn to the better after the signing of the Brussels convention in 1902, whereby all sugar-producing countries, with the exception of Russia, agreed to abolish the system of premiums and artificial protection of the beet sugar industry.

From that time on the development took a regular course, except for a short period in 1917, when, due to a lack of shipping facilities, the crop could not be moved.

TOTAL PRODUCTION OF SUGAR

	Short Tons	Area in Acres
1895	636,726	190,167
1900	818,683	224,527
1905	1,143,096	260,807
1910	1,408,330	312,011
1915	1,450,996	372,773
1920	1,698,315	384,869
1925	2,530,003	440,787
1928	3,284,708	

The present crop is estimated at between 3,355,000 and 3,465,000 short tons.

Cane Culture

The total area of cultivated lands on Java is 10,002,680 bouws, or 17,504,690 acres, of which 4,511,405 *bouws* are *sawahs* of rice fields and 5,491,275 *bouws* non-irrigated lands. The area occupied as cane land was gradually increased:

1840	78,165	acres
1850	87,679	"
1860	98,396	"
1870	94,808	"
1880	112,086	"
1890	129,859	"
1900	224,527	"
1910	312,011	"
1920	384,869	"
1929	479,558	"

But even today the area in cane is but 5½ per cent of the total irrigated area of Java. Except for a small area which depends on rainfall (*tegallans*), the entire Java cane crop is grown on irrigated lands. The land itself is rented from the natives under voluntary agreement and for periods limited by governmental decree, with the general restriction that no more than one-third of the total *sawah* or rice area may be in cane at any one time. The rental has gradually increased, as may be seen from the following statistics taken from the annual report for 1928 of the General Syndicate:

1916	$ 9.16 per acre
1920	14.64 per acre
1927	19.41 per acre

water included. The rotation runs more or less as follows:

September first year	finish of cane harvest
September first year to November first year	secondary products which require but little irrigation—beans, peanuts, etc.
November first year to April second year	rice crop (west monsoon crop)
April second year to November second year	secondary products
November second year to April third year	rice crop
April third year to September fourth year (about 17 to 18 months)	sugar cane

As soon as the last rice crop has been harvested, the plantation administration takes charge and begins with the first field operations, which consist of opening up the soil. During the west monsoon the fields have been saturated with water and in order to make it suitable for cane growth the soil must be exposed to the sun and reoxidized.

To do so, a system of soil treatment introduced by a Cuban, Alvaro Reynoso, is used, which is as follows: First a main ditch is dug to drain the soil, which

ditch is used later in the season as a supply ditch for irrigation water. The field is then divided into plots of one-fifth to one-sixth of an acre by secondary ditches. In these smaller areas plant furrows are dug, generally about 30 feet long, 1 foot deep and at a distance of 4 to 5 feet from center to center. The soil is piled up on the side and between the furrows. It is very important to have this opening of the soil done quickly, that is, immediately after the rice is off, because the new cane crop must have reached a certain growth and root system by the time the heavy rains start in. An abundance of labor is therefore required during this period, and this is not always available, particularly in years when the rice crop has turned out well, because as long as the average Javanese has any cash money at all he prefers rest to work.

As soon as the soil is sufficiently oxidized, the cane is planted, as a rule not later than July. The bottom of the furrow is loosened up and the cane seed laid down at measured distances and with the buds to the side, covered with soil and irrigated as required, generally from 4 to 5 days later. Either at the same time or a little later, doses of ammonium sulphate are applied to each individual plant. The greatest care is taken to bring the young cane to an even stand, and in going over a young plant field you see bamboo sticks placed next to the poor stool to show the spot where a seed had not sprouted and where a new seed piece has been planted, demanding special care and attention as to fertilizer and water.

As the cane grows, the soil which was piled between the furrows is gradually put back so that within two or three months the cane rows are level with the original field again and a little later, as more soil is supplied, the cane stands on a bank or hill, which offers opportunity for drainage. The soil as a rule is of a compact, clayish type, and standing water is harmful for the root system.

Plant Material: Soon after the outbreak and spreading of the Sereh disease, it was found that crops of healthy cane could be grown if the *bibit* was brought in from separate *bibit* plantations situated at a higher altitude. Such a procedure is naturally a very costly one, but with the newly developed P. O. J. varieties, seed can be taken from plantation-grown *bibit,* and the percentage of this source of *bibit* is increasing rapidly:

	1912-13 Per Cent	1919-20 Per Cent	1927-28 Per Cent
Topseed	59	41	23
Plantation *bibit* fields	2	28	57
Mountain *bibit*	39	31	20

Incidentally, where the cost of *bibit* obtained from mountain *bibit* fields varied from $34.00-$60.00 per acre, the present cost for *bibit* of P. O. J. 2878 is around $11.00 per acre. This new variety occupied 12½ per cent of the cane area in 1927, 66½ per cent in 1928, and well over 90 per cent in 1929.

Cost of Operations: As far as individual earnings in the field are concerned, little information is at hand. As a rule, all the lighter operations, such as hoeing, irrigating, fertilizing, are given out in small contract or task work. How much a man makes depends, of course, on the amount of work done, but many of the natives consider the work in the cane field as a kind of side issue. If they run

short in their requirements for their daily support, they put in a few hours' work in the fields, which are always near their homes. The individual working time varies from one to ten hours per day.

For coolies doing the digging of furrows, the average pay runs from $0.22 to $0.40 per day, while for the lighter operations and about six hours' work per day, it will run between $0.14 and $0.18. The writer does not know that the following figure represents an average, but the figure of 300 work days was given as the one required to cultivate and harvest one acre.

Field Administration: Each cane field is a more or less administrative unit, with a *mandoer* (native overseer) in charge, who has under him several temporary assistant *mandoers*. Much of the lighter work, such as assorting of plant material, irrigation, hoeing, fertilizing and hilling up, is exclusively done by women under the direct supervision of woman *mandoers*. As it often happens that a large field is not planted all at the same time, several operations may take place in different parts of the field at the same time, so that much supervision is required.

The direct administration is done by the *mandoer* and controlled by a European overseer, who may have charge of an area of some 500 acres. The cane fields in Java do not form an unbroken unit, due to the peculiar land laws and compelled rotation of crops. A plantation of 2,625 acres has its fields scattered over an area of some 8,000 acres. The European overseers travel in light automobiles to and from the fields, but their actual field work or inspection of row for row is done on foot. No horses can be used in these fields, or gardens, as they are called. In fact, the entire cultivation is more horticulture than agriculture.

The labor is paid off in the field every day, or every other day, with the European overseer responsible for the detailed administration and cost accounting of each operation and field. He also conducts the negotiations with the natives for the rental of this specific cane area.

The plantation manager receives verbal reports of all operations at a certain fixed hour every day, generally at 6:30 p. m., when the entire plantation staff gathers at the plantation office for that purpose. After this report the native *mandoers* receive their orders for the next day's work from their respective section overseers.

Irrigation: On Java, the entire water supply is the property of the government and under its direct management.

The government adheres to the principle that in the east monsoon, or dry season, the cane crop has the preference in the regions assigned to the sugar interests by an official governmental franchise, but that in the west monsoon, the water goes to the native farmer for the growing of foodstuffs.

Therefore, towards the end of October and in November, the cane lands receive no water, even in dry years, and an early rainfall in the last months of the east monsoon is a big factor in the yield to be expected from the growing crop.

Experiments have shown that the yield of a well-started field may be decreased by as much as 1½ tons sugar per acre, if water is withheld in October or November.

To grow 1 K. G. rice about 9 M^3 water are required; for the same quantity of sugar, only 1 M^3 is needed.

Since the supply and distribution of the water is of such immense importance to the industry, the plantations have spent large sums of money to that end. But it is also clear that every cent spent in this direction is of direct benefit to the native population. They profit in two ways. In the first place, they obtain a higher yield (the yield of rice per *bouw* is about double on irrigated areas when compared with *tegallans* or dry lands), and in the second place, they profit on account of the increase in the minimum rentals to be paid for the use of their land.

The sugar industry pays for the supervision of the water distribution as well as for the construction of new irrigation works, extension and upkeep. In the latter case, as a rule, it is three-eighths of the total cost.

During the time period 1915-1924, the sugar industry paid fully 7½ million dollars as its share in the upkeep and extension of the irrigation system.

Harvest: An elaborate system of ripeness determination is in the hands of special field chemists. The results of these determinations form the basis of the harvest schedule. Very seldom the entire field is cut from one end to the other; more frequently a patch here and there is taken, perhaps of only one or two acres. Such practices are possible here because no ratoons are grown, and a very close check is kept that the entire stalk is actually dug out and not cut.

The increase in yield during recent years is well illustrated as follows:

TONS SUGAR PER ACRE (STANDARD MUSCOVADO)

1928	1927	1926	1925
7.07	5.97	5.17	6.02

The following detailed tabulation shows that 51 per cent of the plantations produced more than 7.13 tons sugar per acre:

Short Tons Sugar Per Acre	— Number of Plantations — 1928	1927	1926	1925
2.68 — 3.12	....	1	3	....
3.12 — 3.57	....	....	6	1
3.57 — 4.01	....	2	13	6
4.01 — 4.46	1	3	28	3
4.46 — 4.90	2	10	30	9
4.90 — 5.35	2	24	31	24
5.35 — 5.80	5	31	28	31
5.80 — 6.24	18	47	15	40
6.24 — 6.69	28	26	10	27
6.69 — 7.13	32	18	10	15
7.13 — 7.58	33	8	2	10
7.58 — 8.03	24	5	....	8
8.03 — 8.47	17	1	1	....
8.47 — 8.92	9	1	....	1
8.92 — 9.37	6	1	....	....
9.37 — 9.81	1	....	....	....
9.81 —10.26	1	....	....	....
	179	178	177	175

Manufacture

Most of the factories are making a white plantation sugar either by the sulphitation or the double carbonation process. They make the following assortments:

Superior head sugar (S. H. S.), a product of crystallized sugar, as white as possible and at least equal in color to No. 25 D. S.

Superior soft sugar (S. S. S.), a fine-grained white sugar, at least equal in color to No. 25 D. S.

Head sugar 16/h., also called European assortment, a light-colored, crystallized sugar corresponding in color to No. 16 D. S. and a polarization of at least 98°.

Muscovados, or American assortment of the color numbers 12, 13 and 14 and 96.5° polarization.

Molasses sugars in the numbers 8 and higher.

The cane is transported to the factories in bullock carts, or by rail, but in either case it is absolutely free from trash or tops and piled in neat bundles of from 10 to 15 sticks.

The mill itself, with tile floors and of the low one-story type, is scrupulously clean, well lighted and ventilated. Having seen many of them in different parts of the country, the following points are mentioned as most outstanding:

The growing interest in preparatory machinery, such as shredders and knives.

The different types of top roller surfacing not only the first mills, but the third and fourth mills as well.

The long and heavy carriers between the mills.

The advantage of driving each mill by a separate engine.

The almost universal use of electric power to drive auxiliary machinery and pumps.

The utter cleanliness and the perfectly quiet running of engines, which by no means were always of the latest type.

The automatic and sometimes electric juice scales.

The universal use of vertical juice heaters.

The general adoption of the double carbonation system in favor of sulphitation.

The close control on the boiling process and the use of projector screen to examine the grain in the pan.

The universally adopted system of double purging.

The detailed chemical control and the fact that the chemist spends most of his time in the factory with a native assistant in the laboratory operating the calculating machine.

The universal use of the metric system.

The thoroughness and uniformity of their work and the close cooperation with, and the strict adherence to, instructions given by the technical division of the Experiment Station.

The total recovery of around 85 per cent from juices of 83.85 purity.

Export and Cost

Up to the year 1870, practically the entire Java crop was exported to Europe, principally to the refineries in Amsterdam. After the change to the free sugar culture, England became the chief customer. Around 1900, this market was practically lost due to the protected beet sugar, and America, China and Japan formed the principal outlets next.

After the loss of the American market as a consequence of the Spanish-American war, Java's sales became more and more concentrated on British India and China in the form of white sugar, and by selling direct instead of through refineries in Hongkong and Japan.

The total sugar production for the world runs in the neighborhood of 25 million tons, two-thirds of which is cane sugar. Of this, Java furnishes around 14 per cent.

The chief competitor of Java is Cuba, to the extent of the quantity produced in excess of what America consumes. Next to this country is Formosa, with a rapidly increasing and energetically managed sugar industry bound to enter markets which at present are Java's main outlets.

The cost of production in Java at present varies between f10.00—f12.00 per quintal, or 1.81—2.17c per pound.

The cost of manufacture proper, including salaries, supplies, fuel, wages, bags and transportation to shipping port, f3.00—f3.50 per quintal, or .543—.63c per pound.

The average price received in 1928 varied between f13.00—f14.00 per quintal, or $47.00—$51.00 per ton.

The cost of making white sugar is from f0.75—f1.00 more than that of raw sugar.

The financial returns of the sugar companies are often misunderstood or misrepresented, due to the fact that most of the improvements have been paid for out of profits, while the dividends are generally expressed on the original capitalizations, which were usually small.

Organization

The Java sugar industry is well organized.

The General Syndicate was organized in 1894 and at present 174 of the 179 enterprises belong to it.

Its aim is to further the interests of the industry in a general sense, and deals with problems of taxation, land rent, irrigation, etc. In 1907, the Syndicate was appointed as an official committee of advice to the government in all matters relating to the sugar industry in the Dutch East Indies.

The Experiment Station was first organized in 1885 and has gradually grown to an institution with three main departments, agricultural, technological and engineering. The permanent staff consists of about 45 Europeans, 10 Chinese and 250 natives. In addition it employs 15 European local agents or group advisers in the extension service of the agricultural department.

The Experiment Station has built, at Pasoeroean, 34 houses for the European staff, who are also entitled to free medical treatment and a six months' leave for Europe after five years' service, with free fare and full salary.

The *Archief* for the Java sugar industry is a weekly publication edited by the Experiment Station and devoted mainly to the scientific side of the business.

The Java Sugar Employers Association was founded in 1920. This organization, with which 160 enterprises joined, deals with all questions relating to labor and is the outcome of the labor difficulties and disturbances in 1920.

The three above-named organizations have their own officers but the same president, in whose hands, therefore, rests the general direction of these central organizations of the industry.

A fourth organization is the United Sugar Producers Association of Java. This organization, with its headquarters in Holland, is represented in Java by a committee and a board of advisers. It sells the sugar produced by its members on a cooperative basis and handles fully 90 per cent of the total production.

Another organization is the Association of Owners of Sugar Estates, who reside either in Holland or elsewhere in Europe. They exchange views on, and discuss, questions relating to the sugar trade, and further its interest in a general sense.

The Pension Fund for employees, which provides for a pension for all employees at the age of fifty years, engaged by any of the member plantations, requires no premium to be paid by the employee, but demands that he spend 5 per cent of his salary on an endowment policy which is due at the time the pension is granted.

The Accident Fund has as its aim the lessening of the *risico* for the European and native employee.

The Bouricius Fund supplies support in case of sickness or unemployment and also provides for financial assistance to anyone in need of it who has contributed in some special way to the interest of the sugar industry.

The Royalty Association is a new institution which has opened the way to pay a royalty to those who have occupied themselves with cane breeding and who have developed a new and superior cane variety.

The Association of Employees is a trade organization with 1,800 members, has its own periodical, and is recognized by the General Syndicate.

The Culture Police is an organization under governmental control but paid for by the planters; it was established to furnish particular protection on the plantations against cane fires, thefts, etc.

The European personnel on the plantation receive, besides their salary, a definite share in the yearly profits of the company on a percentage basis, varying from 5 to 10 per cent, according to specific arrangements and position held. Their time of employment is limited, generally not over 20 to 25 years, but in this period they are dismissed or systematically promoted from cane scale employee to factory chemist, superintendent, field overseer, and finally to either head employee or plantation manager.

The plantations, in groups of five or six, maintain well-equipped hospitals, where free medical attendance is furnished to the laborers and their families.

Some of the plantations have established a plantation trade school open to boys of the ages between 10 and 14, where simple mechanical drawing and the making of plantation tools are taught.

As a conclusion, it might be said that Java is absolutely a garden island, and in summing up their accomplishments in industry and administration, they do things as they ought to be done, under the prevailing conditions.

We do not quite agree with those who are of the opinion that only cheap labor made this possible.

We may not be able to adopt their methods because each country has its own problems and pecularities, but we should consider that forethought and wise administration made it as it is. We may not be able to feed our cane plants with a spoon, but it will pay, even in our case, to give more attention to seeing that the fertilizer is applied where the cane roots are able to get it.

Cheap labor is only possible as long as cheap food is obtainable; and an abundant rural population only as long as their land holdings are kept intact.

No administration of 40 million natives by 175,000 Europeans is possible unless the laws are enforced. The ultimate happiness and well-being of the people have no relation to the language they speak, and therefore in the rural schools the Javanese children are taught their native language, and the more educated European is compelled to learn the Javanese and Malayan languages, since they are universally used in dealing with the population.

And it is not far from the truth to state that the reason for the unusual development of the island of Java lies in the fact that it has been governed and managed for centuries by a nation which forever had to struggle with its limited resources in its home country, that had to protect its very soil from being overrun by the ocean, and that could afford no waste of land or material.

Clarification and Its Influence on the Refining Qualities of Sugar

By H. F. Bomonti

Within the past few months, an opportunity was given the writer to investigate the factors responsible for the poor clarification and the poor refining qualities, particularly filtration efficiency and color, of the sugar produced by the Hamakua Mill Company.

Clarification Equipment

Hamakua Mill Company is one of the two factories in the Territory using the Petree Process. The clarification equipment used in this process consists of two Dorr clarifiers. The one known as the primary Dorr has four compartments and a capacity of 2000 cu. ft. The other, known as the secondary Dorr, has three compartments and a capacity of 1600 cu. ft.

The Dorr clarifier itself is a circular steel tank with a fairly flat conical bottom and a parallel conical top. Its interior is divided into a number of comparatively shallow compartments by trays also conical and parallel to the top and bottom. These compartments are separated completely except for the central opening, which extends from the top to the bottom. This forms what is called the mud passage and is common to all compartments. The mud-moving mechanism consists of a vertical shaft which is suspended from a truss on top of the clarifier and passes through the feed well and all the compartments to the bottom of the tank. Attached to this shaft, one just above the bottom of the tank and one just above each of the trays, are the scrapers extending to the side wall of the tank. The mud-moving mechanism is revolved very slowly and pulls the mud to the center well or mud passage.

Just beneath the cover of each compartment at uniformly spaced circumferential points are the clear juice overflow pipes. In each compartment, considered a settling unit, the overflow points are all connected to a header. There are as many take-out pipes for clear juice as there are compartments in the clarifier. The clear juice headers extending from the compartments are connected into an overflow box near the top of the apparatus. Each outlet pipe has a sliding sleeve, thus making it possible to adjust the amount of juice overflow from each compartment.

The mud accumulating in the bottom of the Dorr is withdrawn by a diaphragm pump as rapidly as it forms.

The Petree Process

The system of handling the juices and muds in this process is as follows:

The crusher and first mill juice and also the clarified from the secondary Dorr make up what is called primary juice. This juice is limed, boiled, and sent to the primary Dorr. The mud from the primary Dorr is then mixed with the second mill

juice and after liming and heating, this is sent to the secondary Dorr. The mud from the secondary Dorr is diluted with third mill juice and this is applied to the bagasse blanket behind the first mill.

The primary and secondary juices are limed continuously by a Petree-Dorr liming device. Usually, the primary juice is limed to 8.2—8.3 pH and the secondary juices to 7.3—7.5 pH. One of the objects in reducing the pH of the secondary juice is to keep the volume of settlings from the secondary Dorr at a minimum. When too large a volume of settlings is returned to the bagasse blanket, the extraction of juice from the cane is appreciably affected. Besides this, there would be a tendency for more of the fine suspended matter in the settlings to be returned to the second mill juice.

Theory of Clarification

From our clarification studies a number of years ago, the theory was advanced then that under normal conditions a definite quantity of phosphoric acid was required in juices before a satisfactory clarification could be secured. The phosphate in the juices is precipitated as some form of insoluble calcium phosphate. This precipitate is very flocculent and presumably entangles the finely dispersed matter, removing it from the solution. This view of the mechanism of clarification has been quite widely accepted.

There is another phase of clarification which has not been considered in the past but must be recognized in studying the clarification problem of Hamakua. Our original recommendations for good clarification specified a minimum concentration of 0.03 per cent phosphoric acid as P_2O_5. This means that with such an amount of phosphate sufficient precipitate would be formed to entangle all the coarser dispersed particles, leaving a fairly clear juice. However, it is logical to reason from this assumption that a given quantity of calcium phosphate precipitate can entangle only a certain amount of insoluble impurities. In other words, there must be a limit to the clarifying power of this precipitate. If the amount of insoluble impurities exceeds this limit then additional P_2O_5 would have to be provided to produce a well-clarified juice, otherwise the juice will be murky. The extent of the murkiness will depend on how deficient any juice is in P_2O_5 for the quantity of insoluble impurities to be removed.

Experimental Data

A number of clarification experiments were conducted on both primary and secondary juices to determine whether these juices behaved in the same way as other juices when limed to various reactions, then heated to boiling and allowed to settle. We also wanted to determine whether the maximum clarity was secured at reactions considered the optimum for increase in purity. Tests were made to determine the availability of the phosphates in juices. There is some reason to believe that phosphoric acid can exist in an insoluble form in the suspended matter which would be determined by our method for determining P_2O_5 but actually would not combine with calcium because it might have a greater affinity for this other element and therefore would not produce any clarifying effect. Experiments were also conducted to determine the minimum quantity of P_2O_5 that had to be added to the primary and secondary juices to effect a satisfactory clarification.

Two preliminary clarification series were made on primary juice (crusher and 1st mill juice only) and secondary juice consisting of 2nd mill juice. At the time these samples were taken, no mud was returned to the bagasse blanket. Portions of each juice were limed with varying quantities of lime, heated to boiling and allowed to settle on a steam bath. After settling, the clear portion was decanted and tested for pH and turbidity. The results follow:

PRIMARY JUICE

Cane D 1135 Field—Paauilo 1
Brix—13.3 P_2O_5—.0125 Per Cent

	pH of Clarified Juice	Turbidity
Raw Juice	..	..
Clarified Juice	6.8	2.0
" "	7.5	3.0
" "	8.0	3.5
" "	8.3	3.5
" "	8.3	3.5

SECONDARY JUICE (NO MUD RETURNED)

Cane D 1135 Field—Paauilo 1
Brix—5.0 P_2O_5—.005 Per Cent

	pH of Clarified Juice	Turbidity
Raw Juice	..	1.0
Clarified Juice	6.6	1.0
" "	7.0	1.0
" "	7.7	1.1
" "	8.2	1.7
" "	8.2	1.8

The pH values of the clarified juices are nearer to the pH of the hot limed juice because in these tests the temperature of the juice was not maintaind at or near 212° F. and the time of settling was considerably less than in actual practice.

From the above data it will be noted that the clearest juices were secured at the higher pH values. This confirms our previous findings and shows that no improvement in clarity can be expected by reducing the pH of the limed juices. The primary juice without the addition of secondary clarified juice gave a good clarification considering the low phosphate content. Later experiments will show that when the secondary clarified was added to crusher and first mill juice in the proportion of 1 to 2, the clarification was less satisfactory.

The secondary juice without primary settlings and without returning secondary settlings to the mill was very murky after clarification. With such a low phosphate content it is extremely doubtful if there was any precipitation of phosphate. From other clarification data we find that an amount such as this will usually remain soluble in alkaline solutions. For this reason we cannot expect much of a clarification.

The next clarification series was on secondary raw juice but without the addition of primary mud. However, when this sample was taken secondary mud was being returned to the bagasse blanket behind the first mill. On another sample of secondary juice taken in the manner just mentioned, the writer thought that it was abnormal because it contained such a large amount of suspended matter. It was possible for a shot of mud getting into the second mill juice in case there was a choke in the crusher which would leave a space in the bagasse blanket. For this reason care was taken when sampling the juices to be sure that the mill was operating in the usual way. In this clarification series purities were determined on all samples, including the raw juice both before and after filtration through kieselguhr. On two portions, small amounts of phosphoric acid were added to find out whether a satisfactory clarification could be secured. These juices were then limed to a suitable pH. The results of this clarification series follow:

SECONDARY RAW JUICE (WITHOUT PRIMARY MUD)

Cane D 1135 Field—Paauilo 1 P_2O_5—.0175 Per Cent

	pH	Turbidity	Brix	Purity
Raw Juice	..	.5	7.75	76.13
Raw Juice after kieselguhr filtration	..	..	7.30	80.96
Clarified Juice	7.1	.5	7.80	79.75
" "	7.6	1.3	7.72	81.22
" "	7.8	1.4	7.75	80.40
" "	7.9	1.4	7.80	79.23
" "	7.9	1.7	7.82	80.30
P_2O_5 increased to .0375 per cent	7.6	2.2	7.57	81.11
P_2O_5 increased to .0575 per cent	7.6	4.0	7.51	79.63

Of particular importance in this series is the large change in purity after filtration with kieselguhr. In this case it amounted to 4.83 points in purity. From the appearance of the secondary juice, the writer would estimate that the suspended matter amounted to 1.5-2.0 per cent. This suspended material was very finely divided and quite free from cush-cush. The source of it is undoubtedly secondary mud washed out of the bagasse blanket, for when no mud was returned to the mill, the second mill juice appeared quite normal and free from this large amount of suspended matter. The second mill juice looked more like thin settlings than a low density juice.

Increasing the phosphate content of these juices to .04 per cent and .06 per cent brought about an improvement in clarity. But the quantities necessary for a satisfactory clarification (4.0 turbidity) are prohibitive. Further, the volume of settlings would be increased to such extent as to cause trouble at the mill. It is more than likely that increasing the volume of settlings returned to the mill would increase the amount of suspended matter which would be extracted from the bagasse blanket and returned to the secondary juice.

It has been contended that the addition of the primary settlings to secondary juice brought about a better clarification of this juice. The next clarification series on secondary juice with primary settlings fails to show any such indication:

SECONDARY JUICE WITH PRIMARY SETTLINGS

Cane D 1135 Field—Paauilo 5

	pH	Turbidity	Brix	Purity
Filtered Raw Juice	..	..	7.27	80.33
Clarified Juice	7.9	.5	7.86	79.01
" "	8.0	.5	7.80	79.23
" "	8.0	.5	8.09	78.00

It is very apparent in the above data that adding the primary settlings to the secondary juice and then proceeding with the clarification in the manner already described has not resulted in a clearer juice. Compared with tests conducted without the addition of the primary settlings, the turbidities are all definitely lower. While we have no information as to the increase in suspended solids necessary to reduce the turbidity from 1.0 to .5, the writer would venture the opinion that the amount is more than doubled. There are indications in these data that the purity of the juice is actually depressed due to the solution of some of the suspended

matter. Such an effect has been demonstrated in some early clarification studies conducted a number of years ago.

In view of the data presented so far on the clarification characteristics of secondary juice, the writer concluded that it would not be economically feasible or practical to attempt to improve the clarification as a whole by using treble superphosphate. The writer fails to think of any other place where the mud could be returned to the bagasse blanket without affecting the extraction. It is the writer's understanding that it is the consensus of opinion among users of the Petree Process that the mud should be returned to the mill as far forward as possible. Behind the first mill is as far forward as possible at Hamakua for the cane is not sufficiently disintegrated ahead of this to be in a suitable condition to adsorb the settlings. It would only result in further contamination of the primary juice and possibly without any beneficial effect on the secondary juice.

A number of clarification series were then conducted on the primary juice. As already mentioned, this juice consisted of a mixture of two parts of crusher and first mill juice and one part of secondary clarified juice. Judging from the Brix of this mixture and the Brix of the clarified juice as reported by the laboratory, this is approximately the correct proportion. Therefore, in all these experiments on primary juice this proportion was used. The first clarification series on primary juice was conducted to determine the turbidities and purities at various reactions. In two portions phosphoric acid was added in small amounts to define the minimum quantity necessary to give a satisfactory clarification. The procedure was the same in conducting these tests as that already described. The data for this test follow:

PRIMARY JUICE

Cane D 1135 Field—Paauilo 5 P_2O_5—.0125 Per Cent

	pH	Turbidity	Brix	Purity
Raw Juice	..	..	11.35	81.85
Filtered Raw Juice	..	..	11.23	83.88
Clarified Juice	7.0	1.2	11.96	83.36
" "	7.4	1.7	12.01	83.68
" "	7.6	2.3	11.86	83.47
" "	7.7	2.8	11.64	83.85
" "	7.8	2.7	11.72	84.0
P_2O_5 increased .01 per cent	7.8	3.5	11.70	84.0
P_2O_5 increased .02 per cent	7.6	4.1	11.71	84.0

We have here the indication that the secondary clarified juice actually depressed the clarity of the primary clarified juice. In the first clarification series on crusher and 1st mill juices only, a maximum clarity of 3.5 was found. In this experiment the maximum clarity is 2.8 on the normal primary juice. The addition of .01 per cent and .02 per cent P_2O_5 to raw primary juice increased the clarity of this juice to 3.5 and 4.1, respectively. The increases in purity are rather small, which is characteristic of juices of this type, that is, with low phosphate juices. The maximum purity was found at the maximum pH on the normal primary juice but no difference was found in the purity of the clarified juices to which small amounts of P_2O_5 had been added to the raw juice. Both these purities were 84.0, or the same as the maximum for the normal primary juice.

Although several clarification series were made on primary juice to which small amounts of phosphoric acid were added to the raw juice, only the data from two are given because the results in the other series are practically the same. The data have been arranged in the following tabulation:

	PRIMARY JUICE Cane D 1135 Field—Paauilo 1 .0125 Per Cent—Original P_2O_5 Content of Juice .01 Per Cent P_2O_5 Added				PRIMARY JUICE Cane D 1135 Field—Paauilo 1 .015 Per Cent—Original P_2O_5 Content of Juice .015 Per Cent P_2O_5 Added			
	pH	Turbidity	Brix	Purity	pH	Turbidity	Brix	Purity
Raw Juice	..	..	12.1	83.4	..	..	13.1	82.3
Filtered Raw Juice	..	..	12.0	84.7	..	..	13.0	83.4
Clarified Juice....	6.7	1.2	12.6	84.0	7.0	3.3	13.6	83.4
" "	7.0	2.2	12.6	84.8	7.5	3.3	13.7	83.4
" "	7.5	3.0	12.6	84.8	7.6	4.2	13.5	83.6
" "	7.7	3.4	12.5	84.7	7.9	4.2	13.7	83.7
" "	7.8	3.2	12.4	83.8	7.9	4.3	13.6	83.1

From these data and others it became quite apparent that a very material improvement in the clarity of the juice could be secured by increasing the phosphate content of the primary juice .01-.015 per cent. In the laboratory experiments, there was no indication that the volume of the settlings would be increased to any great extent.

In view of these data, it was suggested that phosphoric acid be added to the juice going to the primary Dorr. This was added to the crusher juice in the form of a solution at the rate of 20 pounds of dry treble superphosphate per hour. A grinding rate of 30 tons cane per hour was assumed. The solution was made in a 50-gallon drum, 62.5 pounds of treble superphosphate being added per barrel. A valve mounted about 1½ inches from the bottom of the barrel was regulated so that the flow from the barrel would be at the rate of 10 inches out per hour. This arrangement is not satisfactory and the writer would suggest that an arrangement similar to the Petree-Dorr liming device be made which would then deliver a definite quantity of this phosphoric acid solution of a definite concentration every 15 or 30 seconds. Without doubt, this arrangement would be far more reliable and regular in its action than any hand-controlled valve, which needs almost constant attention. This experiment started on November 13, 1930, at 8:30 a. m. Samples of juice were taken at regular intervals from each compartment of the primary Dorr and tested for turbidity. The averages of the turbidity of the juice from each compartment for each hour have been tabulated below:

	Turbidities			
	Bottom Tray	2	3	Top Tray
November 13, 1930—				
8:30 a. m.— 9:30 a. m.	1.8	1.6	1.65	1.7
9:30 " —10:30 "	2.0	2.1	2.0	1.7
10:30 " —11:30 "	2.3	2.3	2.3	1.9
11:30 " —12:30 p. m.	2.4	2.6	2.5	2.0
12:30 p. m.— 1:30 "	2.3	2.5	2.4	2.0
1:30 " — 2:30 "	2.5	2.5	2.4	2.0
2:30 " — 3.30 "	3.1	3.2	3.0	2.4

November 14, 1930—				
9:00 a. m.	2.9	2.5	2.4	..
10:00 "	2.4	2.5	2.1	1.6
10:30 "	2.8	2.3	2.2	1.7
11:00 "	2.6	2.4	2.3	1.8

The turbidity figures for the first 5 or 6 hours on November 13, 1930, show a gradual improvment in the clarity of the juices through the addition of .013-.015 P_2O_5. With this type of a clarifier it would require several hours before all the juice is displaced. Nevertheless, the response was very positive. The turbidity figures themselves do not reveal the actual change in the appearance of the juice such as actually happened. According to G. F. Murray, who has had the opportunity to observe the clarified juices over a period of years, the improvement was quite striking. After continuing this experiment for a period of two days, there was no appreciable increase in the volume of the settlings from the primary Dorr. This confirms the observations in the laboratory experiments. The effect that this improved clarity had on the filtrability of sugar from "A" strikes will be discussed later.

Mention was made in the first part of this report that certain tests would be made to determine the availability of the P_2O_5 in the juices. By determining the P_2O_5 content on juices before and after filtration through kieselguhr we can form an opinion of its availability. Kieselguhr being chemically inert will not react with the phosphate actually in solution but will remove such material which is in coarse suspension. In a number of tests when the P_2O_5 content of the juices before and after filtration with kieselguhr was determined, no difference could be found. The conclusion, therefore, has been drawn that all the P_2O_5 in these juices was in solution and therefore in a form which could be precipitated as the insoluble calcium phosphate by the addition of lime.

Boiling System at Hamakua

The boiling system used at Hamakua during the 1930 crop was as follows:

Starting with a footing of seed in No. 2 pan, syrup is taken in until the pan is full, half is then cut over to No. 1 pan and this is completed on syrup making an "A" massecuite of 85-86 purity and yielding "A" molasses around 65 purity. The half remaining in No. 2 pan is completed on syrup and all is then cut over to No. 1 pan. This is then built up to 535 cu. ft. with syrup and finished with "A" molasses and remelt sugar, making a "B" massecuite of 75 purity, which yields molasses of 55-58 purity.

While boiling this "B" strike in No. 1 pan, No. 2 pan is started again as already mentioned, built up to 480 cu. ft. on syrup, half is cut over to No. 1 pan. More syrup is then taken in and finally remelt sugar and "B" molasses, making a massecuite of 70-74 purity, yielding molasses between 50 and 54 purity.

Since the factory started operations in November the two-boiling system advocated by this Station was followed. The "A" massecuites consisted of low-grade sugar for seed and syrup. The "B" massecuites were made of a cut from the "A" massecuites and remelt sugar and "A" molasses. The only reason this system is not followed continuously is on account of a lack of molasses storage capacity.

Filtration Test on Sugar

Three filtration tests were made on sugar from "A" strikes and four tests on sugar from "B" strikes prior to using phosphoric acid in the primary juice. After this treatment was started sugar from two "A" strikes and one "B" strike was tested. These results, together with other data taken from the laboratory records, appear in the table below:

BEFORE USING PHOSPHORIC ACID IN PRIMARY JUICE

	Massecuite			Molasses			Sugar	
	Brix	Pol	Purity	Brix	Pol	Purity	Pol	F.R. 20° C
"A" Strikes—	93.0	77.5	83.3	86.5	54.0	62.4	97.8	62.4
	93.0	77.5	83.3	86.0	52.4	61.0	98.0	69.0
	93.0	79.5	85.3	85.5	54.0	63.2	97.7	68.0
						Average	97.83	68.5
"B" Strikes—	95.0	72.0	75.8	92.6	46.3	50.0	96.9	34.5
	94.5	68.0	72.0	89.5	49.5	55.3	96.1	30.0
	95.0	72.0	75.8	92.5	45.0	48.6	96.7	35.0
	95.0	66.5	70.0	89.0	44.0	49.4	95.5	20.0
						Average	96.3	30.0

AFTER USING PHOSPHORIC ACID IN PRIMARY JUICE CLARIFICATION

	Massecuite			Molasses			Sugar	
	Brix	Pol	Purity	Brix	Pol	Purity	Pol	F.R. 20° C
"A" Strikes—	93.5	80.0	85.6	84.5	52.5	62.1	97.8	87.7
	94.0	80.6	85.7	86.5	54.5	63.0	98.2	89.7
						Average	98.0	88.7
"B" Strikes—	96.0	71.0	74.0	91.5	46.0	50.3	97.3	61.0

A comparison of the data on the "A" sugars produced before and after using phosphoric acid in the clarification of the primary juice shows a large improvement in the filtration efficiency of this sugar. The average filtration efficiency of the "A" strikes prior to this treatment was 68.5 at 97.83 pol, while the average filtration efficiency of two strikes after using the treatment was 88.7 at 98 pol, an increase of over 20 points. Sugar from four "B" strikes before the treatment gave an average filtration rate of 30 at 96.3 pol, while one strike after the treatment had a filtration rate of 61.0 at 97.3 pol. The full effect of this treatment could not be expected, especially in the "B" strikes, until it was in use for several weeks. Low grade sugar boiled prior to the beginning of this treatment is being used for seed and remelted and taken into the "B" strikes. This sugar, which undoubtedly is very poor filtering, contaminates the sugar made from better filtering material.

We are not in a position to run color determinations which would be comparable to Crockett's color figures at the present time. However, judging from the appearance of the sugar made after using phosphoric acid in the primary juice clarification, the writer believes that a material improvement was made.

Conclusions

In conclusion the writer believes that the poor clarification at this factory can be attributed to two factors: (1) The low phosphate content of the juice. (2) The large amount of impurities such as fine suspended matter, which is being washed out of the bagasse blanket and returned to the secondary juice. This results in a very murky secondary clarified juice, which in turn increases the load on the phosphoric acid beyond the limit of its clarifying power. The result is a murky clarified juice.

From the data on filtrability of sugar, is appears that a pronounced improvement can be made in this refining quality by increasing the phosphoric acid content of the primary juice .01-.015 per cent.

A decided decrease in color can be expected judging from the appearance of the sugar.

The writer was assisted by R. K. Hamilton of this Station.

Acknowledgments

This opportunity is taken to thank R. M. Lindsay, manager of the Hamakua Mill Company, and G. F. Murray for their most generous cooperation.

Annual Synopsis of Mill Data

By W. L. McCleery

Operating data for the 39 factories of the Association for the year ending September 30, 1930, are given in this report. The sugar represented by these data amounts to 919,925 tons or an increase from the previous year of slightly over 1 per cent.

Data from eight factories include portions of the previous crop ground after September 30, 1929. Ten factories had not finished their 1930 crop at the close of the Synopsis year, September 30, 1930.

Factories are listed in the order of their average sugar production for the previous five seasons unless otherwise noted. Data for roller grooving and returner bar settings, omitted last year, have been included in the large tables. The order of recording surface grooves has been changed to conform to the usual practice. Data for factory equipment have been omitted this year as it is the intention to alternate this table with data on grooving and returner bar settings in following years. Roller pressures are given in tons per foot of roller in place of total tons as heretofore.

Varieties of Cane

Badila has increased to more than 1 per cent of the total tonnage thus bringing it into our major variety classification. This makes six major varieties against five in the two preceding seasons. H 109 has increased to 56.6 per cent and the percentage of Badila has more than doubled. Yellow Caledonia now makes up slightly less than 20 per cent of the total. Percentages of major varieties, except H 109 and Badila, have decreased materially.

D 1135 is the most widely distributed variety, being reported from 29 factories. H 109 is reported from 22, Yellow Caledonia from 21, and Yellow Tip from 15 factories.

Three-quarters of the tonnage listed as "Others" in Table 1, is accounted for in the minor varieties table. H 5909 and Manoa 213 appear in the minor varieties table for the first time. W 2 and K 73 have been dropped.

MINOR VARIETIES

One Per Cent or More of the Crop at Any Factory

K 107	.72	H 5909	.10
Uba	.67	McB. Seedlings	.07
P O J 36	.67	K 202	.06
H 456	.49	P O J 213	.05
St. Mex.	.29	Manoa 213	.04
U D 1	.24	W 4	.03
H 8965	.16	D 117	.03
Lahaina	.14	R B	.02

TABLE NO. 1
MAJOR VARIETIES OF CANE
(One per cent or more of total crop)

	H 109	Y. C.	D 1135	Yellow Tip	Striped Tip	Badilla	Others
H. C. & S. Co.	99	...	1	...	...	...	...
Oahu	95	...	3	...	...	...	2
Ewa	98	...	...	...	...	...	2
Waialua	97	...	1	...	...	...	2
Maui. Agr	95	...	...	...	...	...	5
Pioneer	97	...	1	...	...	...	2
Olaa	...	86	14	...	...	...	...
Lihue	52	...	5	12	...	15	16*
Haw. Sug	96	...	3	...	...	...	1
Honolulu	100	...	...	...	...	...	...
Kekaha	94	...	1	...	...	...	5
Onomea	...	81	6	11	...	...	2
Hilo	...	90	8	2	...	...	...
Haw. Agr	...	41	58	...	...	...	1
Honokaa	2	3	73	...	...	...	22†
Makee	54	16	...	15	...	6	9
Wailuku	95	...	3	...	...	...	2
Hakalau	...	79	6	14	...	...	1
McBryde	85	1	7	1	...	...	6
Laupahoehoe	...	24	58	17	...	...	1
Kahuku	96	4	...	...	...	...	...
Hamakua	...	8	81	11	...	...	...
Pepeekeo	...	93	3	4	...	...	...
Paauhau	...	1	71	16	...	...	12
Waiakea	...	96	2	...	...	...	2
Koloa	61	...	...	31	...	...	8
Hutchinson	...	44	54	...	...	...	2
Hawi	...	...	37	...	44	...	19‡
Honomu	...	91	7	...	...	...	2
Kaiwiki	...	11	84	3	...	...	2
Kohala	2	2	24	...	24	...	48§
Waimanalo	86	...	2	...	...	...	12
Kilauea	3	9	5	23	4	25	31¶
Kaeleku	...	100	...	...	...	...	...
Waianae	100	...	...	...	...	...	...
Union Mill	...	...	23	1	76	...	...
Niulii	...	18	38	24	20	...	...
Waimea	100	...	...	...	...	...	...
Olowalu	91	...	...	...	...	...	9
True Average 1930	56 6	19.9	12.3	3.5	1.6	1.2	4.9
" " 1929	53 1	21.5	13.0	4.3	2.1	.5	5.5
" " 1928	54.7	20.7	12.9	4.9	2.2	.3	4.3
" " 1927	53.1	23.7	11.8	4.0	1.6	.4	5.4
" " 1926	48.7	25.6	12.1	4.5	2.1	.5	6.5
" " 1925	42.7	30.7	11.9	2.7	2.1	.4	9.5
" " 1924	38.1	32.6	12.0	2.3	2.0	.5	12.5
" " 1923	30.7	36.3	11.2	1.2	1.6	.1	18.9
" " 1922	21.1	40.3	12.2	2.7	1.6	.2	21.9
" " 1921	15.0	45.1	11.0	1.2	1.8	...	25.9

* H 456, 8%
† Uba, 14%
‡ K 107, 11%
§ K 107, 43%
¶ Uba, 26%

K 107 leads the list closely followed by Uba and P. O. J. 36. The percentage of Uba has changed but little. K 107 and P. O. J. 36 have more than doubled. Striped Mexican has decreased to less than a half and Lahaina to less than a quarter of last year's figures. A large decrease in Rose Bamboo has almost eliminated this variety from the minor variety table.

Quality of Cane

We have had much poorer cane this season, the average cane pol having decreased from 12.90 to 12.49 and the first expressed juice purity from 87.18 to 87.04. These changes have increased the quality ratio a quarter of one ton bringing it to 8.83. This is poorer than in any previous year except 1927. There has been practically no change in the average fiber.

On Kauai the cane has improved in quality; on other islands it has been poorer. The quality on Maui has been poorer than in any previous season except 1923, and on Hawaii it is the poorest on record. The islands rank in the usual order, that is, Maui first, followed by Oahu, Kauai and Hawaii in the order named.

The improvement in quality on Kauai is attributable principally to better purity, although the cane pol also has improved slightly. The largest decrease in quality has been on Maui where decreases of almost .8 in cane pol, and over .5 in purity have reduced the calculated *yield per cent cane* by .78. Decreases in quality on Hawaii and Oahu amount to slightly over half of the decrease on Maui. The poorer quality on Hawaii is due principally to a decrease of .5 in cane pol, the decrease in purity being comparatively small. The decrease in cane pol has been smaller on Oahu, but a larger decrease in purity has depressed the quality of cane to approximately the same extent as on Hawaii.

If we had made these comparisons on the usual basis of quality ratio we would have formed a different and quite erroneous idea of the relative size of these changes in the quality. Figures for yield per cent cane and quality ratio, tabulated below, bring this out clearly. Both are calculated on the same basis except that quality ratios are reciprocals of yields per cent cane.

	YIELD % CANE			QUALITY RATIO		
	1929	1930	Difference	1929	1930	Difference
Hawaii	10.49	10.08	—.41	9.53	9.92	+.39
Maui	13.53	12.75	—.78	7.39	7.84	+.45
Oahu	12.20	11.78	—.42	8.20	8.49	+.29
Kauai	11.42	11.60	+.18	8.76	8.62	—.14

According to quality ratio, the decrease in quality on Maui has been slightly greater than the decrease on Hawaii; actually it has been almost twice as large. The decrease on Oahu according to quality ratio has been considerably less than the decrease on Hawaii and about two-thirds of the decrease on Maui; actually it has been about equal to the decrease on Hawaii and to a half of the decrease on Maui. The change in quality on Kauai, according to quality ratios has been a third as large as the change on Maui, while actually it has been less than a quarter as large.

Values for yield per cent cane are rational numbers for they represent direct

TABLE NO. 2

COMPOSITION OF CANE BY ISLANDS

	Hawaii	Maui	Oahu	Kauai	Whole Group
1921					
Pol	12.25	14.67	13.72	12.67	13.12
Per cent Fiber	13.28	11.82	12.40	13.28	12.80
Purity 1st Expressed Juice	87.18	87.37	85.46	84.07	86.22
Quality Ratio	8.98	7.51	8.11	8.76	8.41
1922					
Pol	12.07	13.95	13.61	13.03	12.97
Per cent Fiber	13.16	12.38	12.88	13.22	12.95
Purity 1st Expressed Juice	87.17	87.88	86.18	85.80	86.84
Quality Ratio	9.19	7.75	8.04	8.36	8.45
1923					
Pol	12.09	13.61	12.99	12.94	12.78
Per cent Fiber	13.14	12.01	12.86	12.99	12.82
Purity 1st Expressed Juice	87.61	88.65	85.52	86.58	87.05
Quality Ratio	9.12	7.91	8.50	8.42	8.57
1924					
Pol	12.44	14.34	13.48	13.34	13.26
Per cent Fiber	12.99	12.16	12.72	12.94	12.74
Purity 1st Expressed Juice	87.98	89.19	87.02	87.31	87.86
Quality Ratio	8.86	7.58	8.16	8.12	8.25
1925					
Pol	12.35	14.42	13.52	13.24	13.22
Per cent Fiber	12.92	12.40	12.60	12.91	12.74
Purity 1st Expressed Juice	88.02	89.36	87.11	87.19	87.92
Quality Ratio	8.92	7.47	8.18	8.21	8.28
1926					
Pol	12.53	14.66	13.40	13.03	13.24
Per cent Fiber	12.90	12.24	12.72	12.46	12.65
Purity 1st Expressed Juice	87.59	89.03	86.61	86.68	87.45
Quality Ratio	8.80	7.40	8.29	8.39	8.30
1927					
Pol	11.34	14.00	12.61	12.07	12.32
Per cent Fiber	12.84	11.98	12.29	12.65	12.49
Purity 1st Expressed Juice	86.27	87.85	85.87	85.17	86.28
Quality Ratio	9.81	7.76	8.86	9.19	8.99
1928					
Pol	11.57	14.13	13.09	12.09	12.55
Per cent Fiber	12.58	12.56	12.13	12.82	12.50
Purity 1st Expressed Juice	86.60	88.76	86.84	85.16	86.84
Quality Ratio	9.62	7.60	8.45	9.19	8.79
1929					
Pol	11.80	14.56	13.49	12.64	12.90
Per cent Fiber	12.53	13.24	12.28	12.61	12.62
Purity 1st Expressed Juice	86.65	89.14	87.17	85.97	87.18
Quality Ratio	9.53	7.39	8.20	8.76	8.57
1930					
Pol	11.30	13.77	13.05	12.67	12.49
Per cent Fiber	12.73	12.92	12.35	12.57	12.63
Purity 1st Expressed Juice	86.59	88.60	86.98	86.34	87.04
Quality Ratio	9.92	7.84	8.49	8.62	8.83

TABLE NO. 3

True averages of all factories except those using the Petree Process

	1925	1926	1927	1928	1929	1930
Cane—						
Pol	12.99	12.99	12.05	12.30	12.63	12.27
Fiber	12.80	12.71	12.55	12.47	12.54	12.62
Tons per ton sugar	8.45	8.50	9.24	9.03	8.75	9.00
Bagasse—						
Pol	1.54	1.58	1.50	1.53	1.55	1.51
Moisture	41.25	41.09	41.61	41.36	41.46	41.42
Fiber	56.55	56.64	56.20	56.42	56.31	56.41
Pol % cane	0.35	0.35	0.33	0.34	0.34	0.34
Pol % pol of cane	2.69	2.73	2.77	2.76	2.72	2.75
Milling loss	2.73	2.79	2.66	2.72	2.74	2.67
Weight % cane	22.63	22.44	22.33	22.11	22.26	22.37
First Expressed Juice—						
Brix	18.14	18.24	17.17	17.45	17.76	17.36
Pol	15.91	15.88	14.74	15.08	15.40	15.04
Purity	87.67	87.05	85.84	86.41	86.69	86.68
"Java ratio"	81.7	81.8	81.7	81.6	82.1	81.5
Mixed Juice—						
Brix	13.44	13.65	12.88	13.04	13.29	12.98
Pol	11.38	11.48	10.67	10.89	11.15	10.87
Purity	84.67	84.12	82.88	83.47	83.89	83.73
Weight % cane	111.03	110.10	109.71	109.87	110.18	109.77
Pol % cane	12.64	12.64	11.71	11.96	12.29	11.93
Extraction	97.31	97.27	97.23	97.24	97.28	97.25
Extraction ratio	21.0	21.5	22.1	22.1	21.7	21.8
Last Expressed Juice—						
Pol	1.90	2.06	1.88	1.94	1.99	1.94
Purity	69.63	68.72	67.76	68.39	68.73	68.54
Imbibition water % cane	33.66	32.54	32.04	31.99	32.44	32.15
Syrup—						
Brix	63.63	64.21	62.91	63.05	63.38	64.09
Purity	85.95	85.49	84.54	84.86	85.24	85.17
Increase in purity	1.28	1.37	1.66	1.39	1.35	1.44
Lbs. avail. CaO per ton cane	1.56	1.66	1.52	1.46	1.38	1.30
Press Cake—						
Pol	2.17	2.49	2.22	2.34	2.27	1.82
Weight % cane	2.45	2.63	2.67	2.87	2.87	2.96
Pol % cane	0.05	0.07	0.06	0.07	0.07	0.05
Pol % pol of cane	0.41	0.50	0.49	0.55	0.52	0.44
Commercial Sugar—						
Pol	97.23	97.29	97.40	97.49	97.64	97.66
Moisture	0.74	0.66	0.64	0.62	0.58	0.56
Weight % cane	11.83	11.77	10.83	11.08	11.43	11.11
Pol % cane	11.50	11.45	10.55	10.80	11.16	10.85
Pol % pol of cane	88.78	88.41	87.96	88.21	88.59	88.85
Pol % pol of juice	91.24	90.95	90.45	90.70	91.06	91.36
Deterioration factor	0.27	0.24	0.25	0.25	0.25	0.24
Final Molasses—						
Weight % cane	2.82	2.94	3.02	2.97	2.98	2.89
Sucrose % cane	0.93	0.99	1.01	0.98	0.98	0.94
Sucrose % pol of cane	7.20	7.63	8.37	8.00	7.77	7.67
Sucrose % pol of juice	7.40	7.84	8.60	8.22	7.98	7.88
Gravity solids	90.09	89.59	89.43	88.77	88.82	88.77
Gravity purity	36.97	37.62	37.40	37.41	37.13	36.69
Undetermined Losses—						
Pol % cane	0.16	0.13	0.11	0.11	0.09	0.08
Pol % pol of cane	0.92	0.73	0.41	0.48	0.40	0.30

measures of quantities; they are in simple arithmetical ratio to each other and therefore are directly comparable. As quality ratios represent tons cane per ton sugar they are reciprocals of yield per cent cane and are not rational numbers. They are not proportional to each other and it is not permissible to compare them directly.

Discrepancies discussed above illustrate well the errors involved in making direct comparisons of these reciprocal values. Notwithstanding these errors, tons cane per ton of sugar is used almost exclusively in Hawaii for comparing quality of cane and decisions are made on the basis of these comparisons which are not mathematically permissible. As figures for tons cane per ton of sugar can neither be averaged nor compared directly, discarding these reciprocal values in favor of yields per cent cane which are comparable would be a progressive move. We have been thinking so long in terms of tons cane per ton of sugar that the change may seem difficult, yet the difficulty should not be nearly as great as might be anticipated.

Chemical Control

The control is on a sucrose basis at 33 factories, the same number as last year.

The mixed juice is weighed at one additional factory bringing the total to 36, and the molasses is weighed at two additional factories, bringing the total to 30. Molasses weights calculated from measurements are reported from 7 of the factories, leaving two from which neither weights nor measurements are reported.

One factory only has failed to report any pH data against 5 last year. The pH of the limed juice has been reported from all but two non-Petree factories and in one instance only was the pH determined on the cold juice. This is a marked improvement over last year when 6 non-Petree factories did not report this figure and in three instances the determinations were on the juice before heating.

We would again note that Tables 4 and 5 are largely checks on the accuracy of the chemical control though data therein may disclose avoidable losses, that due to discrepancies in control methods recovery per cent available can slightly exceed 100 per cent and that the actual amount of molasses is considerably less than the calculated theoretical.

Referring to these tables we find a change in a tendency which has been noticeable for a number of years. Each season the number of factories reporting 100 per cent recovery or over on the calculated available has increased until this year, when the number has decreased. On the pol basis (Table 4) 25 factories have reported 100 per cent or over, a reduction of 3. Thirteen have reported 100 per cent or over on a sucrose basis (Table 5), a reduction of 2. On the other hand, the number reporting over 101 per cent has increased from 11 to 13 on the pol basis and from 2 to 4 on the sucrose basis.

The calculation of molasses produced on theoretical in Table 4 is based on the theoretical being the difference between gravity solids in the syrup and in the sugar produced, while the s.j.m. formula is used for calculating the theoretical amount in Table 5. There should not be very large differences between the two sets of figures in the absence of large errors in the control, hence their value in checking the accuracy of the control. Several years ago when these two sets of

TABLE NO. 4

APPARENT BOILING-HOUSE RECOVERY

Comparing per cent available sucrose in the syrup (calculated by formula) with per cent pol actually obtained.

Factory	Available*	Obtained	Recovery on Available	Molasses Produced on Theoretical†
H. C. & S. Co.	93.58	94.77	101.3	93.5
Oahu	92.58	94.39	102.0	90.3
Ewa	92.61	92.45	99.8	85.4
Waialua	91.60	92.41	100.9	90.1
Maui Agr.	93.36	94.91	101.7	98.6
Pioneer	92.44	92.21	99.8	93.0
Olaa	91.32	91.08	99.7	92.3
Lihue	90.75	92.08	101.5	87.3
Haw. Sug.	93.03	94.73	101.8	91.4
Honolulu	92.05	92.16	100.1	91.5
Kekaha	91.05	90.73	99.6	86.6
Onomea	91.90	92.40	100.5	92.2
Hilo	91.62	90.47	98.7	89.1
Haw. Agr.	90.96	91.37	100.5	93.8
Honokaa	90.13	90.16	100.0	91.2
Makee	88.82	88.42	99.5	87.4
Wailuku	90.73	91.60	101.0	93.5
Hakalau	91.82	93.02	101.3	91.3
McBryde	92.15	93.42	101.4	94.0
Laupahoehoe	93.42	93.42	100.0	89.8
Kahuku	90.39	93.08	103.0	91.7
Hamakua	92.27	91.68	99.4	99.6
Pepeekeo	92.14	92.40	100.3	93.7
Paauhau	88.80	87.79	98.9	89.0
Waiakea	90.15	90.33	100.2	87.6
Koloa	91.67	92.93	101.4	92.1
Hutchinson	91.85	93.26	101.5	89.0
Hawi	88.47	89.08	100.7	85.6
Honomu	91.48	92.62	101.2	94.4
Kaiwiki	89.10	88.43	99.2	87.9
Kohala	89.44	89.95	100.6	92.6
Waimanalo	87.96	88.99	101.2	89.4
Kilauea	84.98	83.87	98.7	91.7
Kaeleku	87.55	85.55	97.7	83.0
Waianae	90.93	91.27	100.4	82.7
Union Mill	87.28	86.73	99.4	91.2
Niulii	84.89	87.22	102.7	...
Waimea	90.29	86.74	96.1	...
Olowalu	89.71	88.96	99.2	85.2

* In order to calculate the available sucrose it is necessary to estimate the gravity purity of the syrup and sugar. Data from factories determining both apparent and gravity purities indicate that the average correction necessary is the addition of 0.8 to the apparent purity of the syrup and 0.3 to the apparent purity of the sugar. When moisture in sugar has not been reported, the moisture corresponding to 0.25 deterioration factor has been used. 38 has been used when the gravity purity of the molasses has not been reported.

† Gravity solids in syrup, less solids accounted for in commercial sugar considered as theoretical gravity solids in final molasses.

TABLE NO. 5

TRUE BOILING-HOUSE RECOVERY

Comparing per cent sucrose available and recovered

Factory	Available	Obtained	% Recovery on Available	Molasses Produced on Theoretical*
H. C. & S. Co.	93.58	94.17	100.6	89.6
Oahu	92.83	93.16	100.4	86.9
Ewa	92.88	91.49	98.5	90.6
Waialua	91.81	90.88	99.0	90.1
Maui Agr	93.19	94.64	101.6	92.8
Pioneer	92.40	91.57	99.1	95.7
Olaa	90.91	90.78	99.9	90.5
Lihue	90.93	90.85	99.9	85.3
Haw. Sug	93.02	94.17	101.2	86.0
Honolulu	92.35	90.93	98.5	97.5
Kekaha	91.09	90.24	99.1	89.8
Onomea	91.96	91.96	100.0	93.3
Hilo	91.33	90.19	98.8	92.6
Haw. Agr	91.18	90.24	99.0	96.0
Honokaa	90.14	89.65	99.5	92.7
Makee	88 98	87.20	98.0	90.5
Wailuku	91.03	90.61	99.5	94.1
Hakalau	91.79	92.55	100.8	88.4
McBryde	92.21	92.47	100.3	91.3
Laupahoehoe	93.34	93.07	99.7	91.6
Kahuku	90.68	91.67	101.1	86.8
Hamakua	92.03	91.68	99.6	101.5
Pepeekeo	92.09	92.22	100.1	94.6
Paauhau	88.66	87.29	98.5	92.2
Waiakea	90.27	89.37	99.0	89.1
Koloa	91.73	92.19	100.5	89.5
Hutchinson	91.73	92.78	101.1	84.5
Honomu	91.44	92.12	100.7	91.6
Kohala	89.54	89.30	99.7	93.0
Waimanalo	87.94	88.45	100.6	87.4
Kilauea	84.79	83.36	98.3	93.2
Waianae	90.91	90.31	99.3	82.0
Olowalu	89.47	88.63	99.1	87.3

* Calculated by S. J. M. formula.

TABLE NO. 6

GRAVITY SOLIDS AND SUCROSE BALANCES

Factory	GRAVITY SOLIDS PER 100 GRAVITY SOLIDS IN MIXED JUICE				SUCROSE PER 100 SUCROSE IN MIXED JUICE			
	Press Cake	Commercial Sugar	Final Molasses	Undetermined	Press Cake	Commercial Sugar	Final Molasses	Undetermined
H. C. & S. Co.	4.2	81.6	13.3	0.9	0.52	93.68	5.75	0.05
Oahu	5.5	78.3	14.4	1.8	0.39	92.80	6.23	0.58
Ewa	6.8	75.0	15.5	2.7	0.38	91.14	6.45	2.03
Waialua	2.4	78.1	16.9	2.6	0.16	90.73	7.38	1.73
Maui Agr.	..	84.6	15.2	0.2	....	94.64	6.32	—0.96
Pioneer	5.0	76.2	17.4	1.4	0.29	91.30	7.27	1.14
Olaa	13.3	69.5	15.7	1.5	1.22	89.67	8.23	0.88
Lihue	3.7	76.0	17.3	3.0	0.38	90.50	7.74	1.38
Haw. Sug	4.0	80.3	14.4	1.3	0.16	94.02	6.00	—0.18
Honolulu	5.2	76.0	17.2	1.6	0.34	90.62	7.46	1.58
Kekaha	4.3	75.4	17.7	2.6	0.47	89.82	8.00	1.71
Onomea	4.2	77.4	17.2	1.2	0.19	91.79	7.50	0.52
Hilo	5.1	74.6	18.0	2.3	0.24	89.97	8.03	1.76
Haw. Agr.	3.3	76.8	18.4	1.5	0.30	89.97	8.47	1.26
Honokaa	5.9	72.8	19.5	1.8	0.58	89.13	9.14	1.15
Makee	4.6	70.4	21.4	3.6	0.46	86.80	9.97	2.77
Wailuku	6.8	74.4	17.5	1.3	0.63	90.04	8.44	0.89
Hakalau	3.8	77.5	17.1	1.6	0.18	92.38	7.26	0.18
McBryde	3.0	78.1	17.5	1.4	0.46	92.04	7.11	0.39
Laupahoehoe	3.3	80.1	15.0	1.6	0.10	92.98	6.10	0.82
Kahuku	5.2	73.2	19.5	2.1	0.31	91.39	8.09	0.21
Hamakua	..	79.8	20.1	0.1	....	91.68	8.09	0.23
Pepeekeo	6.1	75.4	17.6	0.9	0.36	91.89	7.48	0.27
Paauhau	5.3	71.3	20.7	2.7	0.50	86.85	10.45	2.20
Waiakea	4.4	73.6	19.0	3.0	0.58	88.85	8.67	1.90
Koloa	6.1	74.8	17.6	1.5	0.70	91.54	7.40	0.36
Hutchinson	6.3	75.3	16.3	2.1	0.19	92.60	6.99	0.22
Honomu	6.6	74.6	17.7	1.1	0.17	91.96	7.84	0.03
Kohala	5.7	72.6	20.2	1.5	0.77	88.61	9.73	0.89
Waimanalo	6.4	68.8	22.1	2.7	0.58	87.94	10.54	0.94
Kilauea	4.8	65.1	27.5	2.6	1.66	81.98	14.18	2.18
Waianae	3.8	75.3	16.9	4.0	0.93	89.47	7.45	2.15
Olowalu	6.7	71.2	18.8	3.3	0.49	88.20	9.19	2.12

Factory	Cane Sucrose*	MIXED JUICE		SYRUP		SUGAR		Undetermined Loss per 100 Sucrose* in cane
		Sucrose	Gravity Purity	Gravity Purity	Increase in Purity	Sucrose	Sucrose per 100 Sucrose* in cane	
H. C. & S. Co.	14.45	11.47	89.14†	89.11	—0.03	98.05	92.04	0.05
Oahu	13.63	11.94	87.15	87.86	0.71	98.41	91.02	0.57
Ewa	13.40	11.70	84.66	87.14	2.48	98.57	89.67	2.00
Waialua	13.54	11.94	86.5	87.2	0.7	98.55	87.58	1.67
Maui Agr	14.63	12.18	87.92†	88.22	0.30	97.77	92.55	—0.94
Pioneer	13.57	11.89	84.99	86.40	1.41	98.27	89.43	1.12
Olaa	12.12	11.72	85.7	87.1	1.4	97.99	86.39	0.84
Lihue	12.79	11.37	85.1	85.7	0.6	98.09	88.22	1.34
H'aw. Sug.	14.33	12.21	86.40	87.69	1.29	98.22	92.24	—0.18
Honolulu	13.79	11.81	86.58	88.2	1.62	100.0	88.19	1.53
Kekaha	13.32	11.41	85.06	86.14	1.08	98.20	87.65	1.67
Onomea	11.33	9.89	84.93	86.54	1.61	97.82	90.04	0.51
Hilo	11.24	9.87	84.49	85.47	0.98	97.37	87.91	1.72
Haw. Agr.	11.67	11.57	86.34	86.84	0.50	98.27	87.51	1.23
Honokaa	10.27	9.85	82.64	84.99	2.35	97.83	83.41	1.08
Makee	11.66	10.43	82.5	83.2	0.7	97.60	83.27	2.66
Wailuku	12.35	10.14	84.9	87.0	2.1	98.23	88.31	0.87
Hakalau	10.95	9.28	83.74	84.99	1.25	96.75	91.04	0.18
McBryde	13.13	10.94	84.89	85.70	0.81	97.92	89.73	0.38
Laupahoehoe	11.85	10.24	87.00	87.81	0.81	98.18	90.16	0.79
Kahuku	11.38	9.99	81.72	83.18	1.46	98.31	89.33	0.20
Hamakua	11.56	10.80	85.71†	85.82	0.11	97.93	88.05	0.22
Pepeekeo	11.54	10.68	83.49	85.86	2.37	98.12	89.66	0.26
Paauhau	10.94	9.33	83.01	84.73	1.72	97.53	84.36	2.13
Waiakea	12.04	10.63	83.97	84.88	0.91	97.88	85.36	1.82
Koloa	11.99	10.10	82.98	85.11	2.13	98.00	89.08	0.35
Hutchinson	12.16	11.15	83.53	85.06	1.53	97.45	89.95	0.21
Honomu	11.13	9.40	83.11	85.68	2.57	98.28	90.32	0.03
Kohala	10.88	9.36	82.32	84.57	2.25	97.49	85.94	0.86
Waimanalo	11.20	9.45	79.65	81.40	1.75	97.13	86.61	0.93
Kilauea	10.53	9.91	79.85	80.67	0.82	97.70	78.28	2.08
Waianae	13.61	11.94	84.20	85.26	1.06	97.66	87.57	2.10
Olowalu	13.04	10.67	82.36	84.25	1.89	97.01	86.52	2.08
‡True Average 1930	12.67	11.08	85.35	86.49	1.14	98.05	88.90	0.89
" " 1929	13.08	11.44	85.58	86.60	1.02	98.00	88.75	1.05
" " 1928	12.69	11.22	85.15	86.23	1.08	97.86	88.49	1.21
" " 1927	12.46	11.01	84.53	85.86	1.33	97.79	87.96	1.13
" " 1926	13.35	11.68	85.38	86.66	1.28	97.67	88.41	1.20

* Pol in bagasse and press cake has been assumed to be the same as sucrose in calculating sucrose in cane.
† Clarified juice. ‡ Refinery data from Honolulu not included in averages.

figures were first compiled there were wide variations between corresponding figures and also extremely high and low figures for production per cent theoretical. In recent years the results have been more consistent indicating improvement in the accuracy of the control. The yearly average molasses produced on theoretical in both Tables 4 and 5 is close to 90 per cent. Assuming that a difference of 5 on either side of 90 per cent of the theoretical in Table 5 should include all reasonably accurate figures, we find that 4 factories are above and 2 are below these limits, while in 1929, 5 factories were above and 6 below.

Table 6 contains gravity solids and sucrose balances for the factories reporting sucrose. Two factories have reported negative undetermined losses of sucrose though none have reported negative undetermined losses of solids. In both respects the above conditions are the same as last year.

Table 7 is a compilation of sucrose data from the 33 factories so reporting. These data represent 96 per cent of the crop, the same proportion as last year.

Undetermined losses on a pol basis are too low, chiefly though not wholly because sucrose in final molasses is used in making up the pol balance. Undetermined losses on the pol basis for factories included in Table 7 (sucrose basis) have again been averaged to determine the difference for all factories reporting on both bases. The difference this year is .84. By adding this figure to .14, the undetermined loss in the large table, we obtain .98 as the corrected average undetermined loss for 1930.

Table 3 is again given, with true averages for all factories except the three reporting on the Petree process basis. These data should be used when making certain comparisons rather than the averages in the first large table.

Milling

The average quality of milling work was about the same as in 1929, although we have had such unfavorable factors as a .4 decrease in cane pol and a 1.6 per cent increase in grinding rate. The extraction was 97.34 against 97.35 last year, and the extraction ratio 21.1 against 21.0. The milling loss improved from 2.72 to 2.63, this figure being a new record. Undiluted juice in bagasse per cent fiber, the figure used in Java for comparing milling results, was 21.8 for both years. A condensed table of milling data follows:

Year	Tons Cane per Hour	Tonnage Ratio	Tonnage Fiber Ratio	Tons Pressure per Linear Foot Roller	Imbibition Water per Cent Cane	Milling Loss	Extraction Ratio	Extraction
1922....	39.93	1.54	19.9	65.2	34.75	3.02	23.3	96.98
1923....	42.03	1.56	20.0	66.2	35.12	2.76	21.6	97.23
1924....	43.63	1.62	20.6	66.9	34.90	2.78	21.0	97.33
1925....	45.31	1.71	21.8	66.5	33.63	2.82	21.3	97.29
1926....	46.43	1.78	22.5	67.4	33.61	2.88	21.7	97.25
1927....	47.87	1.78	22.2	68.2	32.53	2.73	22.2	97.23
1928....	49.30	1.83	22.9	70.5	32.16	2.75	21.9	97.26
1929....	50.98	1.89	23.9	70.4	33.26	2.72	21.0	97.35
1930....	51.79	1.92	24.2	70.6	33.26	2.63	21.1	97.34

As mentioned earlier the grinding rate increased 1.6 per cent. This is the ninth successive yearly increase and the rate of grinding has increased nearly 42 per cent during the period. The average pressure per linear foot of roller increased from 70.4 to 70.6 tons, and while we have not had an increase in all recent years the overall increase for the nine crops that this figure has been averaged, amounts to 8 per cent.

Imbibition water per cent cane, 33.26, was the same as the previous year. The number of factories with increases and decreases were about evenly divided. The trend of this figure had been downward for the six crops preceding 1929.

Bagasse pol was the lowest on record, 1.49 against 1.54 the year previous. Lower figures than the year before were reported from two-thirds of the factories. Bagasse moisture was 41.25 against 41.24 in 1929. The plus and minus changes in moisture were about equally divided between the factories. The moisture averages just given are not the lowest on record, but are lower than for any year since 1921.

The difference in purity between first expressed juice and mixed juice increased to 2.96 from 2.80, a record low figure last year. The purity difference between first expressed juice and last mill juice also increased from 18.10 to 18.42. These purity differences are more or less influenced by mill sanitation and the amount of field trash accompanying the cane. Sanitation has been improving in recent years due to cleaner mills, faster grinding and the change in several factories to the use of unstrained mill juice pumps. We have reason to believe, however, that the amount of field trash accompanying the cane increased considerably on account of the abnormal amount of wet weather during the harvest season.

Mechanical improvements for the 1930 crop were, with the exception of one factory, largely in the boiling house, rather than in the milling plant. Honolulu factory removed their shredder, added another 3-roller mill and made other changes, which have resulted in improved milling work.

Table 8 lists the factories in the order of milling loss; Waimanalo and Hakalau are in first and second place for the third successive year. Ewa is now in 5th place and was 10th on the list in 1928. Olowalu occupies 6th place compared with 9th in 1929 and 14th in 1928. Pioneer is in 9th place, having risen from 17th place in 1929 and 25th in 1928. Hawaiian Sugar is now 10th, and was 21st two years ago. H. C. and S. Company is 11th, and was 15th in 1929 and 26th in 1928. Waimea was 30th in 1928, 23rd in 1929 and is now 18th. McBryde is 19th, compared with 32nd in 1929. Waianae has improved from 31st to 21st place in two years and Honolulu has improved from 34th to 28th place the past year. Factories that have dropped six places or more are Hamakua, Kekaha, Lihue and Paauhau.

Seven factories have bettered their positions four places or more and they are about equally divided between increases and decreases in grinding rate, but they all report an increased amount of imbibition water. Of the four factories that have poorer positions to the extent of 6 places or more, mentioned in the preceding paragraph, three report an increase and one a decrease in grinding rate and two have decreased imbibition while two have increased this figure. The influence of imbibition on milling loss was also discussed in the Synopsis last year.

TABLE NO. 8—MILLING RESULTS

Showing the rank of the factories on the basis of milling loss.

Rank	1929 Rank	Factory	Milling Loss	Extraction Ratio	Extraction	Imbibition	Tonnage Ratio	Tonnage Fiber Ratio*
1	1	Waimanalo.....	1.25	11.4	98.46	38.19	1.99	27.0
2	2	Hakalau.....	1.27	11.7	98.54	37.05	1.67	20.8
3	4	Honomu.....	1.66	15.2	98.20	35.90	1.52	18.0
4	3	Onomea.....	1.71	15.2	98.07	34.45	2.14	27.2
5	6	Ewa.....	1.74	13.2	98.36	34.89	1.62	20.1
6	9	Olowalu.....	1.82	14.1	98.09	41.75	1.65	22.4
7	5	Hilo.....	1.90	17.0	97.69	35.00	1.96	26.6
8	8	Wailuku.....	1.96	16.2	98.05	39.79	1.21	14.6
9	17	Pioneer.....	2.07	15.4	97.93	36.25	2.24	30.1
10	14	Haw. Sug.....	2.09	14.6	98.09	37.48	1.72	22.4
11	15	H. C. & S. Co...	2.10	14.7	98.23	44.23	1.65	19.9
12	11	Oahu.....	2.13	15.9	98.06	32.92	1.96	23.9
13	12	Kahuku.....	2.15	19.3	97.71	30.68	1.73	20.6
14	13	Pepeekeo.....	2.17	18.8	97.57	27.46	1.90	24.5
15	7	Paauhau.....	2.19	20.2	97.10	38.79	1.07	15.4
16	19	Hawi.....	2.22	19.4	97.39	23.88	2.07	27.8
17	18	Maui Agr.....	2.34	16.0	97.78	41.29	1.72	23.8
18	23	Waimea.....	2.37	18.0	97.75	29.95	1.62	20.2
19	32	McBryde.....	2.48	19.1	97.46	39.51	1.47	19.5
20	21	Koloa.....	2.48	20.8	97.29	37.61	1.43	18.6
21	28	Waianae.....	2.52	18.8	97.85	30.76	1.57	17.9
22	25	Hutchinson.....	2.65	22.1	97.12	27.85	1.94	25.3
23	20	Kohala.....	2.66	24.8	96.96	33.86	1.58	19.3
24	10	Lihue.....	2.74	21.9	97.43	31.07	2.34	27.5
25	22	Haw. Agr.....	2.83	24.6	97.23	18.36	2.01	22.7
26	16	Kekaha.....	2.85	21.6	97.57	33.59	2.18	24.5
27	24	Laupahoehoe...	2.86	24.3	96.95	33.60	1.87	23.4
28	34	Honolulu.....	3.18	23.3	97.27	34.13	1.56	18.3
29	26	Kilauea.....	3.39	32.4	95.46	27.45	1.72	24.1
30	27	Makee.....	3.49	30.4	95.86	31.07	2.29	31.2
31	35	Kaiwiki.....	3.58	31.0	96.16	24.52	1.73	21.4
32	33	Waialua.....	3.62	27.3	96.45	34.34	3.01	39.1
33	30	Olaa.....	3.62	30.0	96.31	22.81	2.33	28.6
34	31	Waiakea.....	3.69	31.1	96.02	32.59	1.66	21.3
35	29	Hamakua.....	3.71	32.1	96.01	26.18	1.42	17.7
36	36	Kaeleku.....	4.41	39.3	94.42	31.30	1.85	26.3
37	39	Union Mill.....	4.68	45.2	93.40	20.60	1.66	24.2
38	37	Honokaa.....	5.01	49.2	93.53	23.93	1.77	24.1
39	38	Niulii.....	5.84	61.9	90.85	25.09	1.94	28.7

* Tonnage ratio multiplied by per cent fiber in cane.

No records for extraction or milling loss have been broken this year by any factory. Factories reporting 98 extraction or over, number 10 against 9 last year, a previous maximum figure; H. C. and S. Co., and Olowalu report over 98 extraction this year, while Hilo has dropped below this figure.

Milling loss of less than 2.0 has been reported from 8 factories compared with 6 last year. The previous maximum was 8. The additional factories this year are Wailuku and Olowalu.

Boiling House Work

Clarification: The purity increase from mixed juice to syrup for non-Petree basis factories (Table 3) has increased to 1.44 from 1.35 last year. These figures are considerably below the maximum of 1.66 in 1927. Less lime, as available CaO, per ton of cane has been used this year, 1.30 lbs. against 1.38 lbs. last year, also less lime per cent non-sugars in mixed juice, the figures being 2.81 per cent for 1930 compared with 2.92 per cent for 1929. The average pH on hot limed juice has remained practically the same after making adjustments for the few factories reporting cold limed juice. A smaller proportion of factories have reported limed juice of less than the recommended minimum of 8.0 pH while two of the larger factories have reduced their reaction below 8 pH.

The larger purity difference between first expressed juice and mixed juice indicates the probability that more non-sugars than usual were extracted during milling, due to an increased amount of field trash. We have reason to believe from work done on last mill juices that a part of these non-sugars are quite readily precipitable in the clarification process. Such would favor the obtaining of a better purity increase from mixed juice to syrup.

The turbidity of clarified juice, 3.45 against 3.62 the previous year, is the lowest for the four years that these figures have been averaged.

Filtration of Settlings: Work at the filtration station has again improved. The loss per cent pol in cane (Table 3) is .44 against .52 last year. The present figure is the lowest for five years, and the loss is 15 per cent under last year, due chiefly to improved work at a number of the larger factories. The loss was lower at 17 factories, higher at 18 and without change at 2 factories. Oahu factory added one more Oliver vacuum filter to their equipment and their loss this year is less than half of that two years ago. Waialua discarded their old presses, installed new equipment and have reduced their cake loss to a low figure. Filtration equipment has been increased at 3 other factories. Cake pol (Table 3) was reduced from 2.27 to 1.82, or 20 per cent. There was a slight increase in weight of cake per cent cane, 2.96 against 2.87 last year, or 3 per cent.

Evaporation: Syrup density has increased to a record figure. The Brix is 64.34 compared with 63.65 last year and 63.04 in 1928. The calculated amount of evaporation per hour has increased 2.6 per cent this year. There were moderate increases of evaporator heating surface at 2 factories.

Commercial Sugar: The pol of commercial sugar has reached a new high figure of 97.66 though the increase was only .02. Twenty factories report increases against 17 reporting decreases. The Crockett refinery factories averaged 97.77

pol and those shipping to Western refinery 96.84. The spread in pol between the two groups was .93 this year and .87 last year.

Moisture and deterioration factor are both at new low figures. Moisture is .56 against .58 last year and the deterioration factor is .239 compared with .246 last year. The number of factories with a better deterioration factor has increased considerably, and factories reporting a factor above .25 number only 6 this year compared with 13 last year. Factories with just .25 were 6 this year and 7 last year.

Low Grade Sugar: The purity of low grade sugar is given in the first large table together with averages for six years. The purity increased slightly the first five years, but there has been a drop of .9 this year to the present figure of 75.7. Twenty-four factories reported lower purity this year, 14 higher purity and 1 no change.

Molasses: Final molasses purity is now at a new low record, 36.69, or .33 below the previous low figure of 1929. This is the fourth successive season that a lower figure has been obtained. The lower average this year is largely due to reductions in purity at the larger factories. Factories reporting lower purity than last year number 16 against 22 reporting higher purity. Additional crystallizer capacity was installed at one factory and three factories improved centrifugal equipment. Kahuku again has the lowest purity for the year, 32.84. The record low figure for the islands, 31.81, was established by the same factory in 1927.

The sucrose loss per cent pol in cane was slightly higher than last year, 7.45 against 7.40, in spite of the lower molasses purity, this being due to the lower juice and syrup purities.

In the following table the factories are listed in the order of molasses purity:

GRAVITY PURITY FINAL MOLASSES

32—33	33—34	34—35	35—36	36—37
Kahuku ...32.84	Ewa 33.91	Hutchinson.34.31	Haw. Sug..35.26	Oahu 36.09
	Koloa 33.91	Pepeekeo ...34.31	Honomu ..35.48	Onomea 36.20
	McBryde ..33.91	Pioneer 34.33		Hilo 36.22
		Hamakua ..34.46		Honolulu ...36.38
		Laup. 34.58		Waimanalo .36.54
		Hakalau ...34.74		Waianae ...36.62
				Maui Agr...36.66

37—38	38—39	39—40	Over 40
Lihue 37.00	Olowalu 38.61	Wailuku 39.39	Kilauea 40.22
H. C. & S. Co..37.15	Haw. Agr. 38.77	Kaeleku 39.43	Olaa 40.2
Makee 37.22	Kohala 38.80		Paauhau 40.82
Waialua 37.22	Hawi 38.81		Niulii 42.00
Waiakea 37.26			Kaiwiki 43.35
Kekaha 37.45			Union Mill ...43.80
Honokaa 37.76			

The number of factories in the above tabulation with molasses over 40 purity is one less than last year. In the 33 to 34 purity column there are 3 factories with identical figures, arranged alphabetically, and all tying for second place in the list. There are now 12 factories reporting molasses over 38 purity compared with 14 so reporting last year. None of the factories that still employ string proof boiling methods rather than crystallization in motion, report less than 38 purity and 5 out of the 6 factories listed in the last column follow the older practice.

TABLE NO. 9

COMPARISON OF ACTUAL AND THEORETICAL RECOVERIES

Rank	Factory	Recovery % Calculated Recovery *			Recovery % Recovery Indicated by "Sugar Ratio" †	
		Milling	Boiling House	Over All	Rank	Over All
1	Kahuku	97.71	105.20	103.14	1	102.44
2	Hakalau	98.54	102.31	101.12	3	100.92
3	Haw. Sug.	98.09	102.46	100.74	2	101.19
4	Oahu	98.06	102.06	100.40	4	100.65
5	Honomu	98.20	101.95	100.40	5	100.60
6	Maui Agr.	97.78	101.93	100.08	6	100.21
7	McBryde	97.46	102.39	100.07	12	99.53
8	Hutchinson	97.12	102.70	100.06	7	100.12
9	Waimanalo	98.46	101.18	99.90	14	99.04
10	Koloa	97.29	102.25	99.87	11	99.55
11	Ewa	98.36	100.81	99.44	9	100.02
12	H. C. & S. Co.	98.23	100.85	99.30	8	100.04
13	Onomea	98.07	100.86	99.24	10	99.93
14	Lihue	97.43	101.29	99.08	15	98.92
15	Pepeekeo	97.57	101.20	98.93	13	99.08
16	Pioneer	97.93	100.68	98.91	16	98.68
17	Laupahoehoe	96.95	100.85	98.05	18	98.18
18	Wailuku	98.05	99.52	97.92	19	98.18
19	Waianae	97.85	99.81	97.92	21	97.85
20	Honolulu	97.27	100.20	97.70	17	98.53
21	Waialua	96.45	100.83	97.69	20	97.88
22	Hawi	97.39	99.45	97.27	26	96.85
23	Hamakua	96.01	100.57	97.16	27	96.01
24	Haw. Agr.	97.23	99.62	97.13	22	97.55
25	Kekaha	97.57	99.11	97.11	23	97.26
26	Hilo	97.69	99.02	97.00	25	96 93
27	Olowalu	98.09	98.16	96.62	28	95.94
28	Kohala	96.96	99.14	96.42	24	97.12
29	Waiakea	96.02	99.72	96.08	29	94.95
30	Makee	95.86	99.24	95.67	31	94.55
31	Olaa	96.31	97.52	94.32	30	94.69
32	Paauhau	97.10	96.75	94.22	32	93.40
33	Honokaa	93.53	99.32	93.40	33	93.19
34	Waimea	97.75	95.05	93.18	35	92.99
35	Kaiwiki	96.16	96.10	92.71	34	93.17
36	Kilauea	95.46	95.21	91.59	36	89.87
37	Kaeleku	94.42	95.17	90.19	37	89.40
38	Niulii	90.85	97.71	89.19	39	87.84
39	Union Mill	93.40	94.88	88.96	38	88.90

* Factories are arranged in the order of the ratio of their recovery to that calculated on the basis of 100% extraction, 37.5 gravity purity molasses and no other losses.

† The basis of this calculation is 98.02 extraction, syrup purity one less than the apparent purity of the first expressed juice, gravity purity of molasses 33.33 and no other losses.

One factory, Oahu, made changes in crystallizer equipment that netted an increase in massecuite capacity of 40 per cent, and resulted in reducing molasses purity 3.17, thus fully justifying the expenditure. Other factories that made good reductions in molasses purity the past year were Waiakea, 2.29, and Hutchinson, 1.68. The former abandoned string proof boiling at the beginning of the 1929 crop and the latter a few years earlier. Hutchinson and Pepeekeo are now tied for fifth place in the above tabulation.

Undetermined Loss: The undetermined loss per 100 pol of cane has again been reduced and is .14, a record low figure. The average sucrose undetermined loss for all factories cannot be determined directly as 6 factories still do not report sucrose figures, but as pointed out under "Chemical Control," by applying the average difference for all factories reporting on both bases, the sucrose undetermined loss would be .98 per cent, or .13 below the corresponding figure for 1929 and a new low figure as calculated in this manner.

Recovery

The boiling house recovery has again increased for the third successive year. The increase this year was from 91.65 to 91.77 and is the highest figure in 21 years. In the earlier years of the sugar industry higher figures were obtained but these could readily be accounted for by the high juice purities then prevailing.

Total recovery is for the second year the highest figure recorded, it having increased .10 to 89.33. The better factory work this year should have increased total recovery about .34, but the poorer quality of cane as represented by lower purity of the first expressed juice and the larger drop from first expressed juice to mixed juice, have reduced the anticipated gain by about two-thirds. These two items reduced recovery in about equal proportion. The better factory work was divided about equally between better low grade work, better clarification and filtration results, and lower undetermined losses.

Quality ratio data compared with tons cane per ton of sugar indicate that due to poorer quality of cane a decrease in sugar yield of 2.96 per cent should have been secured this year while a decrease of 3.19 was realized. Correcting these figures for increase in fiber and the increase in sugar pol, they become 2.83 per cent and 3.31 less than the corresponding figures for last year.

Comparison of Actual and Calculated Recoveries

Table 9 is given in the same form as for the three previous years. The comparisons are based first as in Table 4, on 100 per cent mill extraction 37.5 gravity purity molasses, and no other losses; the second basis is: 98.02 extraction, syrup one less than apparent purity of first expressed juice, 33.3 gravity purity of molasses and no other losses. Large discrepancies in control data can influence these comparative recoveries; however, it is possible to exceed 100 per cent recovery on the theoretical on either basis without the figures being necessarily inconsistent.

These calculations are of value in pointing out the approximate quality of work in the various factories, but drawing too close distinctions is not justified, as a

satisfactory mathematical formula for judging the efficiency of factory operations has not yet been found.

The usual summary of losses is in Table 10.

The calculations in this Synopsis have been made by Mr. A. Brodie assisted by others in this Department.

ANNUAL SYNOPSIS OF MILL DATA—SHOWING RESULTS FROM 39 HAWAIIAN FACTORIES FOR CROP OF 1930

| Factory | Factory No. | Milling Plant (Sizes in Inches) | CANE: Pol | % Fiber | Tons per ton commercial sugar | Tons per hour | Tonnage ratio | Tonnage fiber ratio | BAGASSE: Pol | % Moisture | % Fiber | Pol per 100 cane | Pol per 100 pol of cane | Pol per 100 fiber | Weight per 1000 gallons | Factory No. | FIRST EXPRESSED JUICE: Brix | Pol | Purity | Pol of cane ÷ 100 = Pol | MIXED JUICE: Brix | Pol | Purity | gal. Hot Lbs. Lbs. | Purity | Pol per 100 cane | Pol per 100 pol of cane | Pol per 100 fiber | Weight per 1000 gallons | LAST EXPRESSED JUICE: Extrusion Ratio | IMBIBITION WATER: Weight per 100 cane | Dilution % normal juice | Factory No. | CLARIFIED JUICE: Purity | pH | Turbidity | SYRUP: Brix | Purity | Increase in Purity | pH | PRESS CAKE: Pol | Weight per 100 cane | Pol per 100 pol of cane | Pol per 100 fiber | Weight per 1000 gallons | LIME USED (Pounds available CaO per ton cane): In Juice | In Settings | Total | COMMERCIAL SUGAR: % Moisture | Deterioration Index | Weight per 100 cane | Pol per 100 pol of cane | Pol per 100 pol of juice | Total weight in thousand tons | Purity, raw grade sugar | FINAL MOLASSES: Factory No. | % Moisture | Sucrose per 100 cane | Sucrose per 100 pol of cane | Sucrose per 100 pol of juice | Gravity solids | Gravity purity | UNDETERMINED LOSSES: Pol per 100 cane | Pol per 100 pol of cane | Factory No. | Factory |
|---|---|---

CANE MILL DATA, SEASON OF 1930

Factory	Factory No.	MILLING PLANT (Sizes in Inches)	REVOLVING KNIVES: First Set — Number	First Set — Distance Apart Inches	First Set — Distance From Top Roller Inches	First Set — Revolutions per Minute	Second Set — Number	Second Set — Distance Apart Inches	Second Set — Distance From Top Roller Inches	Second Set — Revolutions per Minute	MILL OPENINGS: Crusher	1st Mill — Front	1st Mill — Back	2nd Mill — Front	2nd Mill — Back	3rd Mill — Front	3rd Mill — Back	4th Mill — Front	4th Mill — Back	5th Mill — Front	5th Mill — Back
H. C. & S. Co.	6	K.(2)ERM34x78,S72,12RM34x78	28	9 3/4	24	1,200	56	5	16	1200	1/16	3/16	1/16	3/16	0	1/8	0	1/8	0	.....	.....
" "	6	K.(2)ERM34x78,S72,12RM34x78	28	9 3/4	24	1,200	48	5	16	1200	1/16	3/16	1/16	3/16	1/32	1/8	0	1/8	0	.....	.....
Oahu	20	K.ERM34x78,S72,12RM34x78	28	5 1/2	18	490					1/8	5/8	0	5/8	0	1/2	0	1/2	0	.....	.....
"	20	K.ERM34x78,S72,12RM34x78	28	5 1/2	18	490					1/8	5/8	0	5/8	0	1/2	0	1/2	0	.....	.....
Ewa	5	K.(2)ERM33x78,18RM34x78	72	1	15	580	72	1	1/2	580	3/8	7/8	0	3/4	0	3/4	0	3/4	0	5/8	01
Waialua	17	K.(2)ERM33x78,12RM34x78	76	1 1/2	16	580	76	1 1/2	2	580	1 1/4	3/8	1/16	3/8	1/16	3/8	0	3/8	0	.....	.....
Maui Agr.	21	K.(2)ERM34x66,12RM34x66	72	7/8	16	650	72	7/8	7/8	520	7/8x1/4	3/8	0	1/2	0	3/16	0	1/16	0	.....	.....
"	21	K.(2)ERM34x66,12RM34x66	72	7/8	16	650	72	7/8	7/8	520	7/8x1/4	3/8	0	1/2	0	3/16	0	1/16	0	.....	.....
Pioneer	10	K.ERM34x78,S72,16RM34x72	27	2 1/2	16	690					1/8	7/16	3/32	7/16	1/32	7/16	1/32	7/16	1/32	7/16	0
Oahu	36	K.ERM34x78,S72,12RM34x78	30	2 1/2	16	600					1/4	7/8	3/8	11/16	1/8	7/16	0	5/16	0	.....	.....
Libue	27	K.ERM34x78,S72,12RM34x78	18	3 3/4	16	517					1/16	15/16	1/16	7/16	0	5/16	0	1/4	0	.....	.....
Haw. Sug.	16	K.ERM37x72,S72,12RM34x78	18	3 3/4	16	740					1/4	5/8	1/16	7/16	0	3/8	0	5/16	0	.....	.....
Honolua	35	K.ERM34x78,S72,12RM34x78	22	3	16	570	26	2 9/16	3	575	1 1/4	1	1/16	1	1/16	5/16	1/8	7/32	0	.....	.....
Kekaha	25	K.ERM24x54,15RM32x60	20	2 1/4	5	710					1 1/2	1	5/16	3/4	1/4	11/16	3/16	9/16	1/8	1/2	1/16
Onomea	34	K.ERM33x60,8x54,12RM32x66	22	2 1/2	16	450					1/4	3/4	1/16	1/2	0	3/8	0	1/4	0	.....	.....
Hilo	33	K.ERM32x66,12RM32x66	24	2 3/8	1	400					7/8	3/4	1/16	1/4	0	1/4	0	1/2	0	.....	.....
Haw. Agr.	30	K.ERM32x66,12RM32x66	22	2 1/2	1	400					5/8x1/2	1/4	1/4	11/16	1/16	1/2	1/16	3/8	0	.....	.....
Honokaa	35	K.ERM33x66,12RM32x66	16	4	16	400	16	4	4 1/2	500	1/2	9/16	1/16	1/2	1/32	3/8	0	3/16	0	.....	.....
Makee	14	K.ERM34x72,S72,9RM34x72	22	3		570					0	5/8	0	5/16	0	1/4	0	.....	.....	.....	.....
Wailuku	2	K.ERC28x72,18RM34x78	26	2 9/16	3	575					1/8	3/8	0	3/8	0	5/16	0	1/4	0	.....	.....
Hakalau	7	K.ERC24x54,12RM9.32x60,3.32x66									1/4	3/4	0	1/4	0	1/8	0	1/4	0	.....	.....
McBryde	41	K.ERC32x74x72,S72,9RM34x84	76	1 1/2	4 1/2	600					5/8	1/2	0	7/16	0	13/32	0	.....	.....	.....	.....
Laupahoehoe	41	K.ERC30x60,9RM32x72	16	3 3/4	1 1/2	400					5/16	1/2	0	1/4	0	3/16	0	.....	.....	.....	.....
Kahuku	43	K.ERC30x60,8x54,9RM34x72	10	6	34 1/2	420					9/16	9/32	0	3/16	0	1/8	0	.....	.....	.....	.....
Hamakua	15	K.ERC30x60,18RM32x60	32	4	8	600					1/4	1/2	0	3/8	0	3/8	0	3/16	0	.....	.....
Papeekeo	19	2RC24x54,9RM32x60									1/8	3/4	0	3/16	0	1/8	0	.....	.....	.....	.....
Paauhau	24	2RC26x60,12RM32x66									0	3/8	0	1/4	0	5/16	0	1/8	0	.....	.....
Waiakea	3	2.ERC27x60,9RM32x60	38	5 1/2		415					1/8	5/16	1/16	1/4	0	1/4	0	.....	.....	.....	.....
Kohala	38	K.ERC27x60,12RM32x66	12	4	8	300					1/8	1/2	1/4	3/8	3/16	1/4	0	3/16	0	.....	.....
Hutchinson	31	K.ERC33x60,9RM32x60	22	2 1/2	1/4	495					5/8x1/16	9/16	1/16	3/8	0	1/4	0	.....	.....	.....	.....
Hawi	26	K.(2)ERC30x54,12RM30x54	22	2 1/2	18	570	18	2 1/2	0	570	5/8	3/16	1/16	1/8	1/16	3/16	0	1/8	0	.....	.....
Honomu	37	3.ERC8x60,9RM32x60									1/2x0	3/8	0	3/16	0	3/16	0	.....	.....	.....	.....
Kukwi	32	K.ERC24x60,9RM32x60	18	2		350					0	9/16	0	1/4	0	1/16	0	.....	.....	.....	.....
Kekaha	40	K.2.ERM33.30x60,9.32x60	12	4	18	375	36	1 1/2	1 1/2	400	1/4	5/8	1/16	3/8	0	1/8	0	1/16	0	.....	.....
Waimanalo	1	K.ERC32x54,9RM30x54	28	1 7/8	3 1/2	550					3/8x0	3/8	1/16	3/16	0	1/8	0	.....	.....	.....	.....
Kilauea	23	K.ERC32x60,9RM32x60	22	2 1/2	3 1/2	460					7/16x1/4	1/4	0	3/16	0	1/8	0	.....	.....	.....	.....
Kaeleku	47	K.ERC24x51,9RM32x60	8	3	3	250					1/4	5/8	1/16	1/4	0	1/8	0	.....	.....	.....	.....
Waianae	9	K.(2).ERC30x60,9RM30x60,3.32x60	44	2 1/2	18	420	44	2 1/2	2	420	1/2x1/16	1/4	0	1/4	0	1/4	0	.....	.....	.....	.....
Union Mill	11	3.ERC32x60,9RM30x60									3/4x1/16	1/4	0	1/4	0	1/8	0	.....	.....	.....	.....
Niulii	39	K.9RM30x54	20	5	3	500					1	1/4	1/16	1/4	1/32	3/16	0	.....	.....	.....	.....
Waimea	4	2RC24x48,12RM26x42									0	1/2	1/8	3/8	0	1/4	0	1/8	0	.....	.....
Olowalu	18	K.ERC28x48,9RM26x48	16	3	3 1/2	610					3/8x0	3/8	0	1/4	0	3/16	0	.....	.....	.....	.....

Factory	Factory No.	RETURNER BAR — DISTANCE FROM TOP ROLLER—INCHES: CRUSHER Toe	CRUSHER Center	CRUSHER Heel	1st Mill Toe	1st Mill Center	1st Mill Heel	2nd Mill Toe	2nd Mill Center	2nd Mill Heel	3rd Mill Toe	3rd Mill Center	3rd Mill Heel	4th Mill Toe	4th Mill Center	4th Mill Heel	5th Mill Toe	5th Mill Center	5th Mill Heel
H. C. & S. Co.	6	.....	.....	.....	1 1/4	1 1/2	2	1 1/4	1 1/2	2	1 1/4	1 1/2	2	1 1/4	1 1/2	2	.....	.....	.....
" "	6	.....	.....	.....	1 1/4	1 1/2	2	1 1/4	1 1/2	2	1 1/4	1 1/2	2	1 1/4	1 1/2	2	.....	.....	.....
Oahu	20	.....	.....	.....	1 1/8	1 9/16	1 7/8	1 5/16	1 7/16	1 7/8	1 5/16	1 7/16	1 13/16	1 7/16	1 5/8	1 13/16	.....	.....	.....
"	20	.....	.....	.....	1 7/16	1 5/8	1 3/4	1 1/4	1 7/16	1 13/16	1 7/16	1 11/16	1 15/16	1 7/16	1 5/8	1 13/16	.....	.....	.....
Ewa	5	.....	.....	.....	1 5/8	1 3/4	1 7/8	1 3/4	1 3/4	1 7/8	1 3/4	1 3/4	1 7/8	1 1/4	1 3/4	1 7/8	1 1/2	1 5/8	1 3/4
Waialua	17	.....	.....	.....	1	1	1	1 3/8	1 3/4	1	1 1/2	1 7/8	1	1 1/2	1 7/8	.....	.....	.....	.....
Maui Agr.	21	.....	.....	.....	1 1/2	.....	1 1/2	.....	.....	1 1/2	.....	.....	1 1/2	.....	.....	1 1/2	.....	.....	.....
"	21	.....	.....	.....	1 1/2	.....	1 1/2	.....	.....	1 1/2	.....	.....	1 1/2	.....	.....	1 1/2	.....	.....	.....
Pioneer	10	.....	.....	.....	1 1/4	1 5/8	1 3/4	1 1/4	1 1/2	1 5/8	1 1/4	1 1/2	1 5/8	1 1/4	1 1/2	1 5/8	1 1/4	1 1/2	1 5/8
Oahu	36	.....	.....	.....	1 1/4	1 7/8	2 1/4	1 1/8	1 3/8	2	1	1 1/4	1 7/8	1 1/8	1 3/8	1 3/4	.....	.....	.....
Libue	27	.....	.....	.....	1	1 1/2	2 1/2	1	1 1/2	2 1/2	1	1 1/2	2 1/2	1	1 1/2	2 1/2	.....	.....	.....
Haw. Sug.	16	.....	.....	.....	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	1 3/16	1 3/8	1 13/16	.....	.....	.....
Honolua	35	.....	.....	.....	1	1 1/2	1 11/16	1 5/8	1 7/8	2 5/8	1 7/8	2 3/8	2 7/8	1 7/8	1 7/16	1 7/8	.....	.....	.....
Kekaha	25	.....	.....	.....	1 1/2	2 1/2	2 1/2	1	2 1/2	2 1/2	1	1 1/2	2 1/2	1	1 1/2	2 1/2	.....	.....	.....
Onomea	34	.....	.....	.....	1 1/8	1 1/4	1 1/2	1	1 1/8	1 3/8	1	1 1/8	1 3/8	1	1 1/4	.....	.....	.....	.....
Hilo	33	.....	.....	13/16	1 3/16	1 5/8	1	1 1/2	1 7/8	1	1 3/8	1 7/8	1	1 1/2	1 11/16	1 5/16	1 3/4	.....	.....
Haw. Agr.	30	1 1/4	1 1/2	2	1 1/4	1 1/2	2	1	1 1/4	1 3/4	1	1 1/4	1 3/4	7/8	1 1/4	1 3/4	.....	.....	.....
Honokaa	35	.....	.....	.....	1	1 1/2	1 3/4	7/8	1 1/4	1 3/4	1	1 1/4	1 3/4	7/8	1 1/4	1 3/4	.....	.....	.....
Makee	14	.....	.....	.....	1	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	1	1 1/2	1 3/4	1	1 1/2	1 3/4	.....	.....	.....
Wailuku	2	.....	.....	.....	1 1/4	1 3/4	1 3/4	1 1/4	1 3/4	1 3/4	1 1/4	1 3/4	1 3/4	1 1/4	1 3/4	1 3/4	.....	.....	.....
Hakalau	7	.....	.....	.....	1	1 1/8	2	7/16	1	2	5/16	7/8	1 7/8	9/16	1 1/16	2 1/16	.....	.....	.....
McBryde	41	.....	.....	.....	1	1 5/8	1 3/4	3	1 3/8	1 5/8	2 1/16	1 1/4	1 11/16	2 1/8	.....	.....	.....	.....	.....
Laupahoehoe	41	.....	.....	.....	1	1 1/4	2	5/8	1 1/16	1 3/4	5/8	1	1 3/4	.....	.....	.....	.....	.....	.....
Kahuku	43	.....	.....	.....	1 1/2	2	2 1/4	1	1 1/2	2	3/4	1	1 3/4	.....	.....	.....	.....	.....	.....
Hamakua	15	.....	.....	.....	11/16	1 3/8	1 3/4	1 1/8	1 1/4	1 3/4	1 1/8	1 1/4	1 3/4	1	1 1/8	1 1/2	.....	.....	.....
Papeekeo	19	.....	.....	.....	1	1 1/2	2	7/8	1 3/8	2	7/8	1 3/8	2	.....	.....	.....	.....	.....	.....
Paauhau	24	.....	.....	.....	7/8	1 1/16	1 9/16	1 1/16	1 5/16	1 7/16	25/32	31/32	1 1/16	13/16	7/8	1 1/16	.....	.....	.....
Waiakea	3	.....	.....	.....	1 1/4	1 3/8	1 3/4	1	1 1/4	1 3/4	1	1 1/4	1 3/4	1	1 1/4	1 1/2	.....	.....	.....
Kohala	38	.....	.....	.....	1	1 1/4	1 1/2	1	1 1/4	1 1/2	1	1 1/4	1 1/2	1	1 1/4	1 1/2	.....	.....	.....
Hutchinson	31	11/16	1 1/16	1 3/8	7/8	1 1/8	1 1/2	7/8	1 1/8	1 1/2	7/8	1 1/8	1 1/2	7/8	1 1/8	1 1/2	.....	.....	.....
Hawi	26	.....	.....	.....	1 1/4	1 1/2	1 5/8	1 1/4	1 1/2	1 5/8	1 1/4	1 1/2	1 5/8	1 1/4	1 1/2	1 5/8	.....	.....	.....
Honomu	37	1/2	1	1	3/4	1 1/8	1 1/4	1/2	7/8	1	3/8	3/4	1	3/4	3/4	1	.....	.....	.....
Kukwi	32	.....	.....	.....	3/4	1 1/8	1 1/4	3/4	1 1/8	1 1/4	3/4	1 1/8	1 1/4	1	1 1/4	1 1/2	.....	.....	.....
Kekaha	40	.....	.....	.....	13/8	1 5/8	2 1/2	1 1/8	1 3/8	1 7/8	1 1/8	1 3/8	1 7/8	1	1 1/4	1 5/8	.....	.....	.....
Waimanalo	1	1	3/4	1 1/8	1 5/8	1 7/8	2 1/2	1 1/8	1 3/8	1 7/8	1 1/8	1 3/8	1 7/8	1 1/8	1 3/8	1 7/8	.....	.....	.....
Kilauea	23	.....	.....	.....	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	1	1 1/4	1 1/2	.....	.....	.....
Kaeleku	47	.....	.....	.....	1 1/4	1 1/2	2	1 1/4	1 1/2	2	3/4	1 1/4	1 7/8	1/2	1	1 1/2	.....	.....	.....
Waianae	9	1	1 1/4	1 1/2	1 3/4	1 3/4	2	1 3/4	1 3/4	2	1	1 1/4	1 3/4	1/2	1	1 1/2	.....	.....	.....
Union Mill	11	.....	.....	.....	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	1	1 1/4	1 1/2	.....	.....	.....
Niulii	39	.....	.....	.....	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	.....	.....	.....
Waimea	4	.....	.....	.....	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	1 1/4	1 1/2	1 3/4	.....	.....	.....
Olowalu	18	3/4	1	1 1/4	3/4	1	1 3/16	1	1 1/4	1 1/2	1	1 1/4	1 1/2	7/8	1 1/8	1 3/8	.....	.....	.....

Factory	Factory No.	WIDTH—INCHES: 1st Mill	2nd Mill	3rd Mill	4th Mill	5th Mill	6th Mill	DISTANCE FROM BACK ROLLER—INCHES: 1st Mill	2nd Mill	3rd Mill	4th Mill	5th Mill	6th Mill
H. C. & S. Co.	6	12 1/2	11 3/4	12 1/4	12 1/2	.....	.....	1/2	1/2	1/2	1/2	...	...
" "	6	12 1/4	12 1/4	12	12 1/2	.....	.....	1/2	1/2	1/2	1/2	...	...
Oahu	20	12 1/2	12 1/8	12 3/4	13	.....	.....	1/2	1/2	1/2	1/2	...	...
"	20	16	16 1/4	15 3/8	15	.....	.....	1 1/8	1 1/16	1/2	1/2	...	...
Ewa	5	16 1/4	16	16 1/2	16	.....	.....	12	12	12	12	12	12
Waialua	17	16 1/4	16	16 1/2	16	.....	.....	3/8	3/8	3/8	3/8	...	...
Maui Agr.	21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
"	21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pioneer	10	15	15	15	.....	.....	.....	1/2	1/2	1/2	.....	.....	.....
Oahu	36	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Libue	27	14	14	14	.....	.....	.....	1/4	1/4	1/4	.....	.....	.....
Haw. Sug.	16	13 3/4	13 1/2	14	.....	.....	.....	5/16	1/4	1/4	.....	.....	.....
Honolua	35	12 1/4	11 1/2	11 3/4	13 3/4	.....	.....	7/16	1/2	3/4	13/16	.....	.....
Kekaha	25	11	11	11	11	.....	.....	3/8	3/8	3/8	3/8	.....	.....
Onomea	34	12 1/2	13	13	.....	.....	.....	1/4	1/4	1/4	.....	.....	.....
Hilo	33	12 1/4	13 1/2	13 3/4	11 1/2	.....	.....	1/2	3/8	3/8	3/8	.....	.....
Haw. Agr.	30	12 1/4	12 1/4	12 1/4	12 1/2	.....	.....	1/2	1/2	3/8	3/8	.....	.....
Honokaa	35	14 1/2	14 1/2	14 1/2	.....	.....	.....	1/2	1/2	1/2	.....	.....	.....
Makee	14	12 1/4	12 1/4	12 1/4	.....	.....	.....	1/2	1/2	9/16	1/2	.....	.....
Wailuku	2	12 1/4	12 1/4	12 1/4	.....	.....	.....	1/2	1/2	1/2	.....	.....	.....
Hakalau	7	12 1/4	11 7/8	12	12 1/4	.....	.....	3/8	5/16	3/8	.....	.....	.....
McBryde	41	13	13 1/2	12 1/4	.....	.....	.....	1/2	1/2	.....	.....	.....	.....
Laupahoehoe	41	10 1/2	11	12	.....	.....	.....	5/8	5/8	1/2	.....	.....	.....
Kahuku	43	11	11 1/2	12 1/2	.....	.....	.....	1/2	1/2	3/8	.....	.....	.....
Hamakua	15	11	12 1/4	12 3/8	11 3/4	.....	.....	5/8	5/8	1/2	3/8	.....	.....
Papeekeo	19	11	13	13	.....	.....	.....	1/2	1/2	1/2	.....	.....	.....
Paauhau	24	11 1/2	11 3/4	12 1/16	11 1/4	.....	.....	1/2	1/2	1/2	.....	.....	.....
Waiakea	3	12 1/2	12 1/2	12 1/2	.....	.....	.....	1/2	1/2	1/2	.....	.....	.....
Kohala	38	10 1/2	10 1/2	11	11	.....	.....	3/8	3/8	3/8	3/8	.....	.....
Hutchinson	31	12 1/2	12 1/2	12 5/8	.....	.....	.....	1/2	1/2	1/2	.....	.....	.....
Hawi	26	10 1/2	10 1/2	10 1/2	10 1/2	.....	.....	3/4	3/4	3/4	7/8	.....	.....
Honomu	37	12 3/4	13 3/4	12 3/4	.....	.....	.....	3/4	3/4	3/4	.....	.....	.....
Kukwi	32	11 1/2	12	12	.....	.....	.....	3/4	3/4	3/4	.....	.....	.....
Kekaha	40	14 3/8	14	14	.....	.....	.....	3/4	3/4	1	1	.....	.....
Waimanalo	1	11	11 1/2	11	.....	.....	.....	3/8	3/8	3/8	.....	.....	.....
Kilauea	23	12 3/4	11 1/2	12 1/4	.....	.....	.....	1	1	1	.....	.....	.....
Kaeleku	47	13	11 1/4	12 1/2	.....	.....	.....	1/2	1/2	1/2	.....	.....	.....
Waianae	9	13	11 1/2	13 1/2	.....	.....	.....	3/8	3/8	1/2	.....	.....	.....
Union Mill	11	10 1/2	11 1/2	.....	.....	.....	.....	1/2	1/2	.....	.....	.....	.....
Niulii	39	13 3/4	8 1/4	12 1/2	.....	.....	.....	1 1/2	1 1/4	1	.....	.....	.....
Waimea	4	11	11	11	.....	.....	.....	1 1/4	1/4	1/4	1/4	...	...
Olowalu	18	11	10 7/16	10 3/8	.....	.....	.....	1/8	3/8	1/2	.....	.....	.....

Factory	Factory No.	SPEED OF ROLLERS—FEET PER MINUTE: Crusher	1st Mill	2nd Mill	3rd Mill	4th Mill	5th Mill	6th Mill
H. C. & S. Co.	6	30	25	24	30	24	...	...
" "	6	30	25	24	30	24	...	...
Oahu	20	37.5	31.2	30	37.5	30	...	...
"	20	37.5	31.2	30	37.5	30	...	...
Ewa	5	20	19	20	23	23	23	23
Waialua	17	40.3	28.1	28.1	29.0	31.3	...	...
Maui Agr.	21	.....	.....	.....	.....	.....	.....	.....
"	21	.....	.....	.....	.....	.....	.....	.....
Pioneer	10	43	26.8	27.9	24.3	26.6	32.0	...
Oahu	36	51.5	30.5	26.5	30.7	36	...	...
Libue	27	55.6	30.4	30.4	31.4	35	...	...
Haw. Sug.	16	32.5	20.2	22	24	25.1	...	...
Honolua	35	39.4	23.4	23.9	22.6	23.9	...	...
Kekaha	25	22	22	23.7	23	23	23	...
Onomea	34	25.4	22.4	22.3	22.5	...	...	...
Hilo	33	40.2	28.6	28.6	26.6	17.5	...	...
Haw. Agr.	30	23.8	22.2	22.5	25.1	27.3	...	...
Honokaa	35	33.3	22.2	19.5	22.5	24.9	...	...
Makee	14	22.6	19.3	22.6	20.5	...	...	...
Wailuku	2	24.6	20.5	16.8	17.8	22.3	...	...
Hakalau	7	30.5	21.6	24.3	28.7	16.1	...	...
McBryde	41	33.5	20.7	20.5	20.5	...	...	...
Laupahoehoe	41	30.5	21.8	17.4	19.3	...	...	...
Kahuku	43	23.6	17.7	20.7	24.8	...	...	...
Hamakua	15	30.5	19.7	19.7	20.1	24.3	...	...
Papeekeo	19	30	24.4	27.5	27.5	...	...	...
Paauhau	24	24.8	17.3	19	17.3	19	...	...
Waiakea	3	20.5	19.5	19.5	21.5	...	...	...
Kohala	38	24.8	17.3	19	17.3	19	...	...
Hutchinson	31	20.5	19.5	19.5	21.5	...	...	...
Hawi	26	38.2	27.3	21.9	23	23	...	...
Honomu	37	51.1	18.3	21	23.3	...	...	...
Kukwi	32	30	24	24	...	...	...	...
Kekaha	40	33.8	24	24	24	...	...	...
Waimanalo	1	21.9	19.8	18.3	16.9	...	...	...
Kilauea	23	79.6	79.6	79.6	79.6	...	...	...
Kaeleku	47	62.0	64.6	62.0	62.4	...	...	...
Waianae	9	70.8	70.8	70.8	70.8	...	...	...
Union Mill	11	60.6	62.2	60.6	60.6	...	...	...
Niulii	39	.....	.....	.....	.....	.....	.....	.....
Waimea	4	18.9	13.6	13.6	14	17	...	...
Olowalu	18	22.5	20.9	20.1	20.1	...	...	...

Factory	Factory No.	PRESSURE ON ROLLERS—TONS PER LINEAR FOOT: Crusher	1st Mill	2nd Mill	3rd Mill	4th Mill	5th Mill	6th Mill
H. C. & S. Co.	6	58.15*	19.9	...	...	...	...	...
" "	6	.....	.....	.....	.....	.....	.....	.....
Oahu	20	14.1	6.1	6.1	6.1	...	...	...
"	20	16.5	6.1	6.1	6.1	...	...	...
Ewa	5	70.77	...	...	...	...	...	...
Waialua	17	105.92	39.1	...	...	...	...	...
Maui Agr.	21	.....	.....	.....

CANE MILL DATA, SEASON OF 1930 (CONTINUED) ROLLER GROOVING

Factory	Factory No.	MILLING PLANT	SURFACE GROOVES PER INCH FRONT, TOP, BACK						
			Crusher	1st Mill	2nd Mill	3rd Mill	4th Mill	5th Mill	6th Mill
H. C. & S. Co.	6	K(2),2RC78,S72,12RM78	Krajewski	1 1/3, 4, 1 1/3	1 1/3, 4, 8	1 1/3, 4, 8	1 1/3, 4, 8		
" "	6	K(2),2RC78,S72,12RM78	Krajewski	1 1/3, 4, 1 1/3	1 1/3, 4, 8	1 1/3, 4, 8	1 1/3, 4, 8		
Oahu	20	K,2RC78,S72,12RM78	Krajewski	1 1/3, 2 2/3, 2 2/3	1 1/3, 2 2/3, 2 2/3	1 1/3, 2 2/3, 2 2/3	1 1/3, 2 2/3, 2 2/3		
" "	20	K,2RC78,S72,12RM78	Krajewski	1 1/3, 2 2/3, 2 2/3	1 1/3, 2 2/3, 2 2/3	1 1/3, 2 2/3, 2 2/3	1 1/3, 0, 0		
Ewa	5	K(3),2RC78,18RM78	Krajewski	1 1/3, 1 1/3, 1 1/3	1 1/3, 2 2/3, 2 2/3	1 1/3, 5 1/3, 5 1/3	1 1/3, 1 1/3, 1 1/3	1 1/3, 2 2/3, 5 1/3	1 1/3, 5 1/3, 5 1/3
Wainlua	17	K(2),2RC78,12RM78	4/5, 4/5	1 1/3, 1 1/3, 1 1/3	1 1/3, 1 1/3, 1 1/3	1 1/3, 5, 2	1 1/3, 2 2/3, 2 2/3		
Maui Agr.	21	K(2),3RC66,12RM66	2/3, 2/3, 2/3	6, 6, 6	6, 6, 6	6, 6, 6	6, 6, 6		
" "	21	K(2),3RC66,12RM66	2/3, 2/3, 2/3	6, 6, 6	6, 6, 6	6, 6, 6	6, 6, 6		
Pioneer	10	K,2RC72,S72,15RM72	Krajewski	1 1/3, 1 1/3, 1 1/3	1 1/3, 4, 4	1 1/3, 4, 4	1 1/3, 4, 4	1 1/3, 4, 4	
Olaa	36	K,2RC78,S72,12RM78	Krajewski	3, 3, 6	3, 6, 6	3, 6, 6	3, 6, 6		
Lihue	27	K,2RC78,S72,12RM78	Krajewski	1 1/3, 1 1/3, 7	1 1/3, 4, 7	1 1/3, 7, 7	1 1/3, 7, 7		
Haw. Sug.	16	K,2RC72,S72,12RM78	Krajewski	4, 4, 4	4, 4, 4	4, 4, 4	4, 7, 7		
Honolulu	13	K(2),2RC78,12RM78	2/5, 2/5	2/3, 2/3, 2/3	1 1/3, 1 1/3, 1 1/3	1 1/3, 6, 6	1 1/3, 6, 6		
Kekaha	25	K,2RC54,15RM60	Krajewski	2/3, 2/3, 2/3	7, 7, 7	7, 7, 7	7, 7, 7	7, 7, 7	
Onomea	34	K,2RC60,S54,12RM66	Krajewski	4, 4, 7	4, 7, 7	4, 7, 7	4, 7, 7		
Hilo	33	K,2RC66,12RM66	Krajewski	2, 5, 5	5, 5, 5	5, 5, 5	5, 5, 5		
Haw. Agr.	30	K,3RC60,12RM66	2/3, 2/3, 2/3	1 1/3, 1 1/3, 1 1/3	4, 4, 4	4, 4, 4	5, 5, 5		
Honokaa	35	K(2),2RC66,12RM66	2/3, 2/3	2 1/2, 2 1/2, 2 1/2	5, 5, 5	5, 5, 5	5, 5, 5		
Makee	14	K,2RC72,S72,9RM72	Krajewski	1 1/3, 3, 7	2 2/3, 3, 7	3, 7, 7	4, 4, 4		
Wailuku	2	K,2RC72,12RM78	Krajewski	1 1/3, 1 1/3, 1 1/3	4, 4, 4	4, 4, 4	4, 4, 4		
Hakalau	7	2RC54,12RM9-60-3-66	Krajewski	5, 5, 5	5, 7, 7	5, 7, 7	7, 7, 7		
McBryde	12	K,2RC72,S72,9RM84	1/2, 1/2	6, 6, 6	6, 6, 6	6, 6, 6			
Laupahoehoe	41	K,2RC60,9RM60	2/3, 2/3	3 1/2, 5, 5	4, 6, 6	7, 8, 8			
Kahuku	43	K,2RC60,S54,9RM72	Krajewski	2, 4, 4	4, 4, 4	4, 5, 4			
Hamakua	15	K,2RC60,12RM60	Krajewski	6, 6, 6	6, 6, 6	6, 6, 6	6, 6, 6		
Pepeekeo	19	2RC54,9RM60	Krajewski	7, 4, 7	7, 7, 7	7, 7, 7			
Paauhau	24	2RC60,12RM66	Krajewski	2 2/3, 4, 4	4, 4, 7	7, 7, 7	7, 7, 7		
Waiakea	3	K,2RC60,9RM60	Krajewski	4, 7, 7	4, 7, 7	4, 7, 7			
Koloa	38	K,2RC60,12RM66	Krajewski	2 2/3, 2 2/3, 2 2/3	2 2/3, 5 1/4, 5 1/4	5 1/4, 5 1/4, 5 1/4	5 1/4, 5 1/4, 5 1/4		
Hutchinson	31	K,3RC60,9RM60	2/3, 2/3, 2/3	4, 4, 4	4, 4, 4	4, 4, 4			
Hawi	26	K(2),2RC54,12RM54	4/5, 4/5	2, 2, 2	2, 3, 3	4, 4, 4	2, 4, 4		
Honomu	37	3RC60,9RM60	2/3, 2/3, 2/3	6, 6, 6	6, 6, 6	6, 6, 6			
Kaiwiki	32	K,2RC60,9RM60	Krajewski	3, 6, 6	6, 6, 6	6, 6, 6			
Kohala	40	K(2),12RM60		2 1/2, 2 1/2, 4	2 1/2, 5, 5	5, 5, 5	5, 5, 7		
Waimanalo	1	K,3RC54,9RM54	2/3, 2/3, 2/3	4, 4, 4	4, 4, 4	4, 4, 4			
Kilauea	23	K,3RC60,9RM60	8/9, 8/9, 8/9	1, 7, 7	4, 7, 7	4, 7, 7			
Kaeleku	47	K,2RC54,9RM60	Krajewski	3, 3, 3	5, 5, 5	5, 5, 5			
Waianae	9	K(2),3RC60,9RM60	1, 1, 1	2/3, 6, 6	2, 6, 7	7, 7, 7			
Union Mill	11	3RC60,6RM60	2/3, 2/3, 2/3	2 1/2, 5, 5	3, 6, 6				
Niulii	39	K,9RM54		2, 2, 2	0, 0, 0	0, 0, 0			
Waimea	4	2RC42,12RM42	Krajewski	8/9, 8/9, 8/9	4, 4, 8	4, 8, 8	4, 8, 8		
Olowalu	18	K,3RC48,9RM48	2/3, 2/3, 2/3	5, 5, 5	5, 5, 5	5, 5, 5			

Factory No.	JUICE GROOVES																																		Factory No.	Factory
	1st Mill						2nd Mill						3rd Mill						4th Mill						5th Mill						6th Mill					
	Front			Back			Front			Back			Front			Back			Front			Back			Front			Back			Front			Back				
	Width	Depth	Pitch	Width	Depth	Pitch	Width	Depth	Pitch	Width	Depth	Pitch	Width	Depth	Pitch	Width	Depth	Pitch	Width	Depth	Pitch	Width	Depth	Pitch	Width	Depth	Pitch	Width	Depth	Pitch	Width	Depth	Pitch	Width	Depth	Pitch		
6	7/32	2 1/4	2 1/4	....	....	....	7/32	2 1/4	2 1/4	7/32	2	2	7/32	2 1/4	2 1/4	7/32	2	2	7/32	2 1/4	2 1/4	7/32	2	2													6	H. C. & S. Co.
6	7/32	2 1/4	2 1/4	....	....	....	7/32	2 1/4	2 1/4	7/32	2	2	7/32	2 1/4	2 1/4	7/32	2	2	7/32	2 1/4	2 1/4	7/32	2	2													6	" "
20	3/8	2	2 1/4	5/16	1 1/2	2 5/8	5/16	2	2 5/8	5/16	2	2 5/8	5/16	2	2 5/8	5/16	1 1/2	2 5/8	5/16	2	2 5/8	5/16	1 1/2	2 5/8													20	Oahu
20	3/8	2	2 1/4	5/16	1 1/2	2 5/8	5/16	2	2 5/8	5/16	2	2 5/8	5/16	2	2 5/8	5/16	1 1/2	2 5/8	5/16	2	2 5/8	5/16	1 1/2	2 5/8													20	" "
5	9/32	2	3	5/32	2	3	9/32	2	3	5/32	2	3	9/32	2	3	5/32	2	3	9/32	2	3	5/32	2	3	9/32	2	3	5/32	2	3	9/32	2	3	5/32	2	3	5	Ewa
17	5/16	1 3/4	4	1/4	1 3/4	4	5/16	1 3/4	4	1/4	1 3/4	4	3/8	1 3/4	4	1/4	1 3/4	4	5/8	1 3/4	4	1/4	1 3/4	4													17	Wainlua
21	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3													21	Maui Agr.
21	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3	5/16	1 1/2	3													21	" "
10	7/32	2	2 1/4	....	....	....	7/32	2	2 1/4	7/32	2	2 1/4	7/32	2	2 1/4	7/32	2	2 1/4	7/32	2	2 1/4	7/32	2	2 1/4	7/32	2	2 1/4	7/32	2	2 1/4							10	Pioneer
36	3/4	1 3/8	3	3/4	1 3/8	2	1/2	1 3/8	3	1/2	1 3/8	2	5/16	1 3/8	3	5/16	1 3/8	2	5/16	1 3/8	3	5/16	1 3/8	2													36	Olaa
27	3/16	1 3/4	3	3/16	1 1/2	3	3/16	1 3/4	3	3/16	1 1/2	3	3/16	1 3/4	3	3/16	1 1/2	3	3/16	1 3/4	3	3/16	1 1/2	3													27	Lihue
16	1/4	1 1/4	2	1/4	1 1/4	2	1/4	1 1/4	2	3/16	1 1/4	2	3/16	1 1/4	2	3/16	1 1/4	2	3/16	1 1/4	2	3/16	1 1/4	2													16	Haw. Sug.
13	....	....	....	....	....	....	1/4	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	3													13	Honolulu
25	....	....	....	....	....	....	1/4	1 1/4	2	3/16	1 3/8	2	1/4	1 1/4	2	3/16	1 3/8	2	1/4	1 1/4	2	3/16	1 3/8	2													25	Kekaha
34	1/4	1 1/2	2	3/16	1 1/2	2	1/4	1 1/2	2	5/16	1 1/2	2	1/4	1 1/2	2	5/16	1 1/2	2	1/4	1 1/2	2	5/16	1 1/2	2													34	Onomea
33	1/4	1 3/4	2	5/32	1 1/2	2	1/4	1 3/4	2	5/32	1 1/2	2	1/4	1 3/4	2	5/32	1 1/2	2	1/4	1 3/4	2	5/32	1 1/2	2													33	Hilo
30	1/4	1 1/2	2	1/4	1 1/2	2	1/4	1 1/2	2	1/4	1 1/2	2	1/4	1 1/2	2	1/4	1 1/2	2	1/4	1 1/2	2	1/4	1 1/2	2													30	Haw. Agr.
35	1/4	1 3/4	2 1/2	1/4	1 3/4	2 1/2	1/4	1 3/4	2	1/4	1 3/4	2	3/16	1 3/4	2 1/2	3/16	1 3/4	2 1/2	3/16	1 3/4	2 1/2	1/8	1 3/4	2													35	Honokaa
14	3/16	1 1/2	3	3/16	1 1/2	2	3/16	1 1/2	3	3/16	1 1/2	2	3/16	1 1/2	3	3/16	1 1/2	3	....	....	....	....	....	....													14	Makee
2	3/16	1 1/2	2 1/4	5/16	1 1/2	2 1/4	1/4	1 1/2	2	5/32	1 1/2	3	1/4	1 1/2	2	5/32	1 1/2	3	3/8	1 1/2	2	3/16	1 1/2	2	1/8	1 1/2	2	1/8	1 1/2	2							2	Wailuku
7	1/4	1 1/2	2	1/8	1 1/2	2	1/8	1 1/2	2	1/8	1 1/2	2	1/4	1 1/2	2	1/8	1 1/2	2	1/4	1 1/2	2	1/8	1 1/2	2													7	Hakalau
12	1/4	1 1/2	3	1/4	1 1/2	2 1/2	1/4	1 1/2	3	1/4	1 1/2	2 1/2	1/4	1 1/2	3	1/4	1 1/2	2 1/2	....	....	....	....	....	....													12	McBryde
41	1/4	1 5/8	2	3/16	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	3	3/16	1 3/4	3	3/16	1 3/4	3	1/4	1 1/2	2 3/4	3/16	1 1/2	2 3/4													41	Laupahoehoe
43	3/16	1 3/4	3	3/16	1 3/4	3	3/16	1 3/4	3	3/16	1 3/4	3	3/16	1 3/4	3	3/16	1 3/4	3	1/4	1 1/2	2 3/4	3/16	1 1/2	2 3/4													43	Kahuku
15	7/32	1 1/2	2 1/4	7/32	1 1/2	2 1/4	7/32	1 1/2	2 1/4	7/32	1 1/2	2 1/4	7/32	1 1/2	2 1/4	7/32	1 1/2	2 1/4	7/32	1 1/2	2 1/4	7/32	1 1/2	2 1/4													15	Hamakua
19	1/4	1 1/2	3	5/32	1 1/2	2	1/4	1 1/2	3	5/32	1 1/2	2	1/4	1 1/2	3	5/32	1 1/2	2	1/4	1 1/2	3	5/32	1 1/2	2													19	Pepeekeo
24	9/64	1 1/2	2 1/4	9/64	1 1/4	2	9/64	1 1/2	2	9/64	1 1/4	2	9/64	1 1/2	2	9/64	1 1/2	2	9/64	1 1/2	2	9/64	1 1/4	2													24	Paauhau
3	1/4	1 1/2	2 1/2	1/4	1 1/2	3	1/4	1 1/2	2 1/2	1/4	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	2 1/2	1/4	1 1/2	3	....	....	....	....	....	....	....	....	....							3	Waiakea
38	3/8	1 1/4	2 5/8	1/4	1 1/4	2 5/8	3/8	1 1/4	2 5/8	5/16	1 1/4	2 5/8	5/16	1 1/4	2 5/8	3/8	1 1/4	2 5/8	3/8	1 1/4	2 5/8	5/16	1 1/4	2 5/8													38	Koloa
31	1/4	1 1/2	2	3/16	1 1/2	2	1/4	1 1/2	2	3/16	1 1/2	2	3/16	1 3/4	2	1/8	2 1/4	2 1/4	....	....	....	....	....	....													31	Hutchinson
26	3/16	1 3/4	2 1/2	3/16	1 3/4	2 1/2	1/4	1 1/2	2	1/4	1 1/2	2	3/16	1 5/8	2	3/16	1 5/8	2	3/16	1 5/8	2	3/16	1 5/8	2													26	Hawi
37	5/32	1 3/4	2	5/32	1 3/4	2	5/32	1 3/4	2	5/32	1 3/4	2	5/32	1 3/4	2	5/32	1 3/4	2	5/32	1 3/4	2	5/32	1 3/4	2													37	Honomu
32	1/4	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	3	1/4	1 1/2	3													32	Kaiwiki
40	....	....	....	....	....	....	1/4	1 1/4	2 1/2	3/16	1 1/2	2 1/2	3/16	1 1/2	2 1/2	3/16	1 3/8	2 1/2	1/4	1 1/2	2 1/2	3/16	1 3/8	2 1/2													40	Kohala
1	3/16	1 1/2	2	3/16	1 1/2	2	3/16	1 1/2	2	3/16	1 1/2	2	3/16	1 1/2	2	3/16	1 1/2	2	3/16	1 1/2	2	3/16	1 1/2	2													1	Waimanalo
23	1/2	1 1/2	2	1/4	1 1/4	2	5/8	1 1/4	2	1/4	1 3/8	3	5/8	1 1/2	2	1/8	1 1/2	2	....	....	....	....	....	....													23	Kilauea
47	1/4	1 1/2	2	1/8	1 1/4	2	1/4	1 1/2	2	1/4	1 1/4	2	1/4	1 1/4	2	1/8	1 1/4	2	....	....	....	....	....	....													47	Kaeleku
9	1/4	1 7/16	1 7/8	1/4	1 5/16	2	1/4	1 1/4	2	1/4	1 1/4	2	1/4	1 1/4	2	1/4	1 1/4	2	....	....	....	....	....	....													9	Waianae
11	5/16	1	3	5/32	1 1/4	3	9/32	1 5/8	3	7/32	1 5/8	3	....	....	....	....	....	....	....	....	....	....	....	....													11	Union Mill
39	1/4	1 1/4	3	1/4	1 1/4	3	3/8	1 1/4	3	3/8	1 1/4	3	1/4	1 1/4	3	1/4	1 1/4	3	....	....	....	....	....	....													39	Niulii
4	....	....	....	....	....	....	....	....	....	1/4	1 1/2	1 1/2	1/8	1/2	1 1/2	1/4	1 1/2	1 1/2	1/8	1 1/2	1 1/2	1/8	1 1/2	1 1/2													4	Waimea
18	3/16	1 1/4	2	3/16	1 1/4	2	3/16	1 1/4	2	3/16	1 1/4	2	3/16	1 1/4	2	3/16	1 1/4	2	....	....	....	....	....	....													18	Olowalu

TABLE NO. 10

SUMMARY OF LOSSES

FACTORY	POUNDS POL PER TON OF CANE					POL PER 100 CANE					POL PER 100 POL OF CANE					Syrup Purity	FACTORY
	Bagasse	Press Cake	Molasses	Undetermined	TOTAL	Bagasse	Press Cake	Molasses	Undetermined	TOTAL	Bagasse	Press Cake	Molasses	Undetermined	TOTAL		
H. C. & S. Co.	5.0	1.4	16.4	—1.6	21.2	0.25	0.07	0.82	—0.08	1.06	1.77	0.52	5.70	—0.59	7.40	88.32	H. C. & S. Co.
Oahu	5.2	1.0	16.6	—2.0	20.8	0.26	0.05	0.83	—0.10	1.04	1.94	0.38	6.21	—0.73	7.80	86.80	Oahu
Ewa	4.4	1.0	17.0	2.4	24.8	0.22	0.05	0.85	0.12	1.24	1.64	0.38	6.45	0.95	9.42	85.64	Ewa
Waialua	9.4	0.4	19.2	0.1	29.1	0.47	0.02	0.96	0.00	1.45	3.55	0.17	7.28	0.02	11.02	85.90	Waialua
Maui Agr.	6.4	...	18.0	—3.6	20.8	0.32	....	0.90	—0.18	1.04	2.22	....	6.21	—1.24	7.19	87.67	Maui Agr.
Pioneer	5.6	0.8	19.4	1.0	26.8	0.28	0.04	0.97	0.05	1.34	2.07	0.29	7.19	0.42	9.97	85.62	Pioneer
Olaa	8.8	2.8	19.2	1.2	32.0	0.44	0.14	0.96	0.06	1.60	3.69	1.18	7.98	0.50	13.35	86.7	Olaa
Lihue	6.4	1.0	19.2	0.0	26.6	0.32	0.05	0.96	0.00	1.33	2.57	0.38	7.67	0.01	10.63	84.6	Lihue
Haw. Sug.	5.4	0.4	17.0	—2.2	20.6	0.27	0.02	0.85	—0.11	1.03	1.91	0.16	5.94	—0.78	7.23	86.98	Haw. Sug.
Honolulu	7.4	0.8	20.0	0.8	29.0	0.37	0.04	1.00	0.04	1.45	2.73	0.33	7.35	0.25	10.66	87.0	Honolulu
Kekaha	6.4	1.2	20.8	3.2	31.6	0 32	0.06	1.04	0.16	1.58	2.43	0.46	7.89	1.19	11.97	85.15	Kekaha
Onomea	4.4	0.4	16.6	0.1	21.5	0.22	0.02	0.83	0.00	1.07	1.93	0.18	7.41	0.03	9.55	85.71	Onomea
Hilo	5.2	0.6	17.6	3.0	26.4	0.26	0.03	0.88	0.15	1.32	2.31	0.24	7.90	1.38	11.83	84.92	Hilo
Haw. Agr.	6.4	0.8	19.2	0.0	26.4	0.32	0.04	0.96	0.00	1.32	2.77	0.30	8.35	0.01	11.43	85.86	Haw. Agr.
Honokaa	13.2	1.2	17.6	1.0	33.0	0.66	0.06	0.88	0.05	1.65	6.47	0.55	8.63	0.52	16.17	84.14	Honokaa
Makee	9.6	1.0	22.4	3.0	36.0	0.48	0.05	1.12	0.15	1.80	4.14	0.45	9.72	1.33	15.64	82.2	Makee
Wailuku	4.8	1.6	20.4	—0.6	26.2	0.24	0.08	1.02	—0.03	1.31	1.95	0.63	8.41	—0.23	10.76	85.7	Wailuku
Hakalau	3.2	0.4	15.6	—0.8	18.4	0.16	0.02	0.78	—0.04	0.92	1.46	0.18	7.22	—0.36	8.50	84.09	Hakalau
McBryde	6.6	1.2	18.2	—1.6	24.4	0.33	0.06	0.91	—0.08	1.22	2.54	0.46	7.02	—0.63	9.39	84.86	McBryde
Laupahoehoe	7.2	0.2	14.0	1.0	22.4	0.36	0.01	0.70	0.05	1.12	3.05	0.10	5.95	0.42	9.52	87.18	Laupahoehoe
Kahuku	5.2	0.6	18.0	—3.0	20.8	0.26	0.03	0.90	—0.15	1.04	2.29	0.32	8.05	—1.31	9.35	82.00	Kahuku
Hamakua	9.2	...	18.0	0.4	27.6	0.46	....	0.90	0.02	1.38	3.99	....	7.81	0.17	11.97	85.17	Hamakua
Pepeekeo	5.6	0.8	16.8	0.2	23.4	0.28	0.04	0.84	0.01	1.17	2.43	0.36	7.33	0.06	10.18	85.10	Pepeekeo
Paauhau	6.2	1.0	22.2	3.2	32.6	0.31	0.05	1.11	0.16	1.63	2.90	0.49	10.28	1.51	15.18	83.78	Paauhau
Waiakea	9.4	1.4	20.0	1.8	32.6	0.47	0.07	1.00	0.09	1.63	3.98	0.56	8.44	0.79	13.77	83.98	Waiakea
Koloa	6.4	1.6	17.2	—1.0	24.2	0.32	0.08	0.86	—0.05	1.21	2.71	0.69	7.27	—0.44	10.23	84.3	Koloa
Hutchinson	7.0	0.4	16.6	—0.8	23.2	0.35	0.02	0.83	—0.04	1.16	2.88	0.19	6.85	—0.31	9.61	84.44	Hutchinson
Hawi	6.0	1.2	22.0	2.2	31.4	0.30	0.06	1.10	0.11	1.57	2.61	0.51	9.64	0.94	13.70	82.73	Hawi
Honomu	4.0	0.4	17.2	—1.2	20.4	0.20	0.02	0.86	—0.06	1.02	1.80	0.16	7.78	—0.54	9.20	84.88	Honomu
Kaiwiki	8.8	1.2	22.4	3.2	35.6	0.44	0.06	1.12	0.16	1.78	3.84	0.56	9.70	1.36	15.46	85.19	Kaiwiki
Kohala	6.6	1.6	20.4	0.4	29.0	0.33	0.08	1.02	0.02	1.45	3.04	0.75	9.52	0.15	13.46	83.73	Kohala
Waimanalo	3.4	1.2	23.2	0.6	28.4	0.17	0.06	1.16	0.03	1.42	1.54	0.58	10.49	0.28	12.89	80.44	Waimanalo
Kilauea	9 4	3.4	28.6	3.0	44.4	0.47	0.17	1.43	0.15	2.22	4.54	1.59	13.65	1.49	21.27	80.1	Kilauea
Kaeleku	12.6	3.2	23.6	6.6	46.0	0.63	0.16	1.18	0.33	2.30	5.58	1.43	10.49	2.95	20.45	82.02	Kaeleku
Waianae	5.8	2.4	19.8	2.8	30.8	0.29	0.12	0.99	0.14	1.54	2.15	0.92	7.42	1.05	11.54	84.32	Waianae
Union Mill	13.6	2.4	23.2	2.0	41.2	0.68	0.12	1.16	0.10	2 06	6.60	1.20	11.22	1.02	20.04	83.89	Union Mill
Niulii	17.2	3.4	....	21.6	42.2	0.86	0.17	....	1.08	2.11	9.15	1.77	....	11.38	22.30	80.64	Niulii
Waimea	6.0	2.2	....	33.8	42.0	0.30	0.11	....	1.69	2.10	2.25	0.81	....	12.85	15.91	84.37	Waimea
Olowalu	5.0	1.2	23.4	4.4	34.0	0.25	0.06	1.17	0.22	1.70	1.91	0.47	9.08	1.70	13.16	83.65	Olowalu

Sugar Prices

96° Centrifugals for the Period Sept. 16 to Dec. 15, 1930.

Date	Per Pound	Per Ton	Remarks
Sept. 16, 1930	3.15¢	$63.00	Cubas.
" 22	3.145	62.90	Cubas, 3.15; Philippines, 3.14, 3.15.
" 23	3.135	62.70	Cubas, 3.13, 3.14.
" 25	3.13	62.60	Cubas.
" 26	3.10	62.00	Cubas.
" 29	3.045	60.90	Cubas.
Oct. 3	3.05	61.00	Cubas.
" 6	3.12	62.40	Porto Ricos.
" 7	3.13	62.60	Cubas, 3.14; Philippines, 3.12.
" 8	3.21	64.20	Cubas, 3.20, 3.22; Porto Ricos, 3.20.
" 9	3.26	65.20	Cubas.
" 10	3.2425	64.85	Cubas, 3.26, 3.25, 3.24, 3.22.
" 14	3.30	66.00	Cubas.
" 20	3.32	66.40	Philippines.
" 21	3.35	67.00	Cubas.
" 23	3.4375	68.75	Cubas, 3.40, 3.43, 3.45; Philippines, 3.45, 3.47.
" 24	3.42	68.40	Cubas, 3.45, 3.41, 3.40.
" 27	3.49	69.80	Cubas, 3.50; Porto Ricos, 3.48.
" 28	3.505	70.10	Cubas, 3.51; Philippines, 3.50.
" 29	3.39	67.80	Cubas.
" 30	3.38	67.60	Cubas.
" 31	3.42	68.40	Cubas.
Nov. 5	3.39	67.80	Cubas.
" 6	3.40	68.00	Cubas.
" 10	3.415	68.30	Cubas, 3.41, 3.42.
" 11	3.41	68.20	Cubas, 3.41; Porto Ricos, 3.40, 3.42.
" 13	3.45	69.00	Porto Ricos.
" 14	3.47	69.40	Cubas, 3.46; Philippines, 3.47; Porto Ricos, 3.48.
" 17	3.45	69.00	Cubas.
" 18	3.4033	68.06	Cubas, 3.42, 3.40, 3.39.
" 19	3.34	66.80	Cubas.
" 25	3.40	68.00	Cubas.
Dec. 2	3.41	68.20	Cubas, 3.40; Philippines, 3.42.
" 3	3.34	66.80	Philippines.
" 6	3.35	67.00	Cubas.
" 9	3.38	67.60	Cubas, 3.39, 3.37.
" 12	3.3533	67.06	Cubas, 3.35, 3.34; Philippines, 3.35; Porto Ricos, 3.37.
" 15	3.305	66.10	Cubas, 3.35, 3.26.